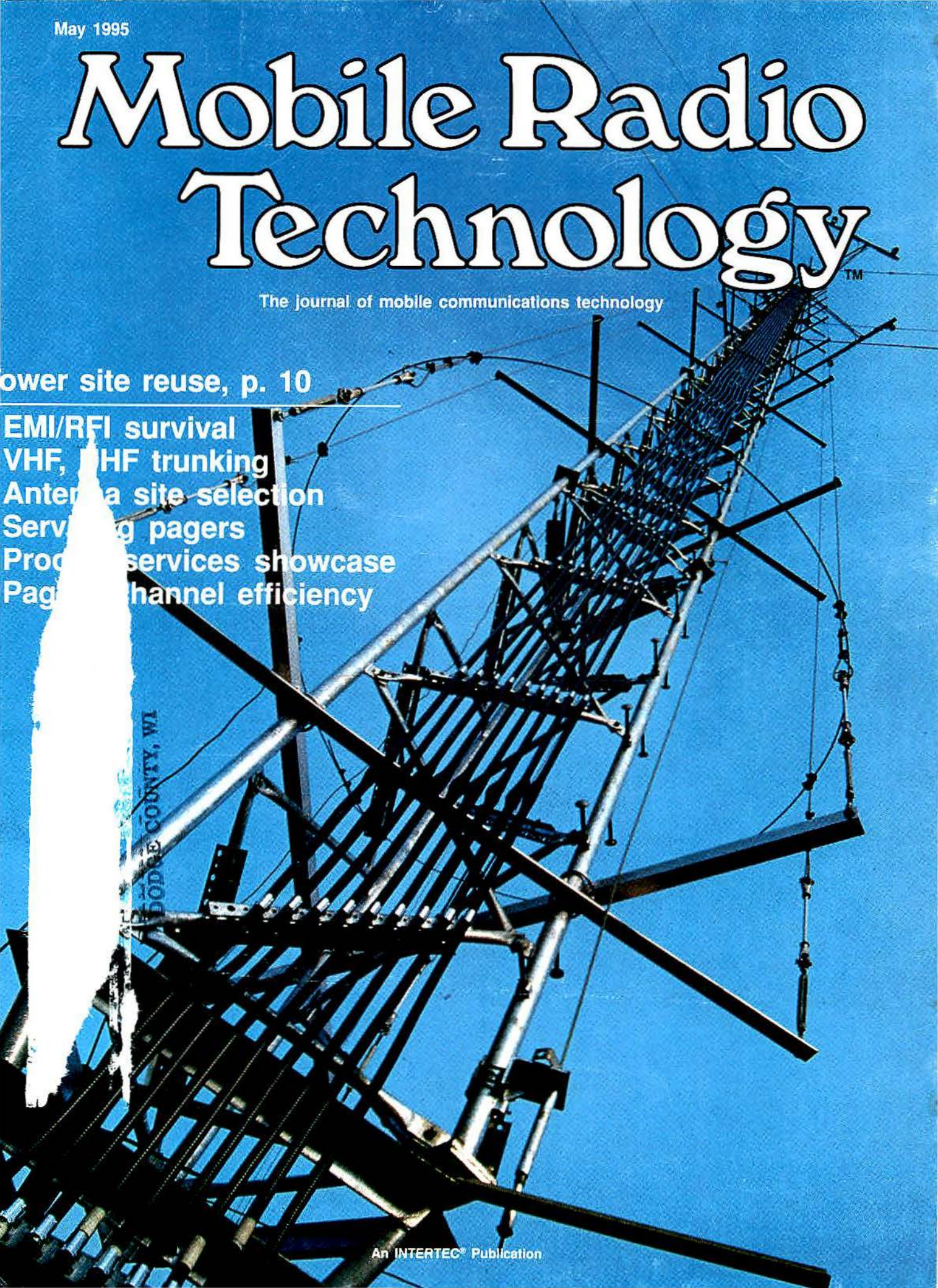
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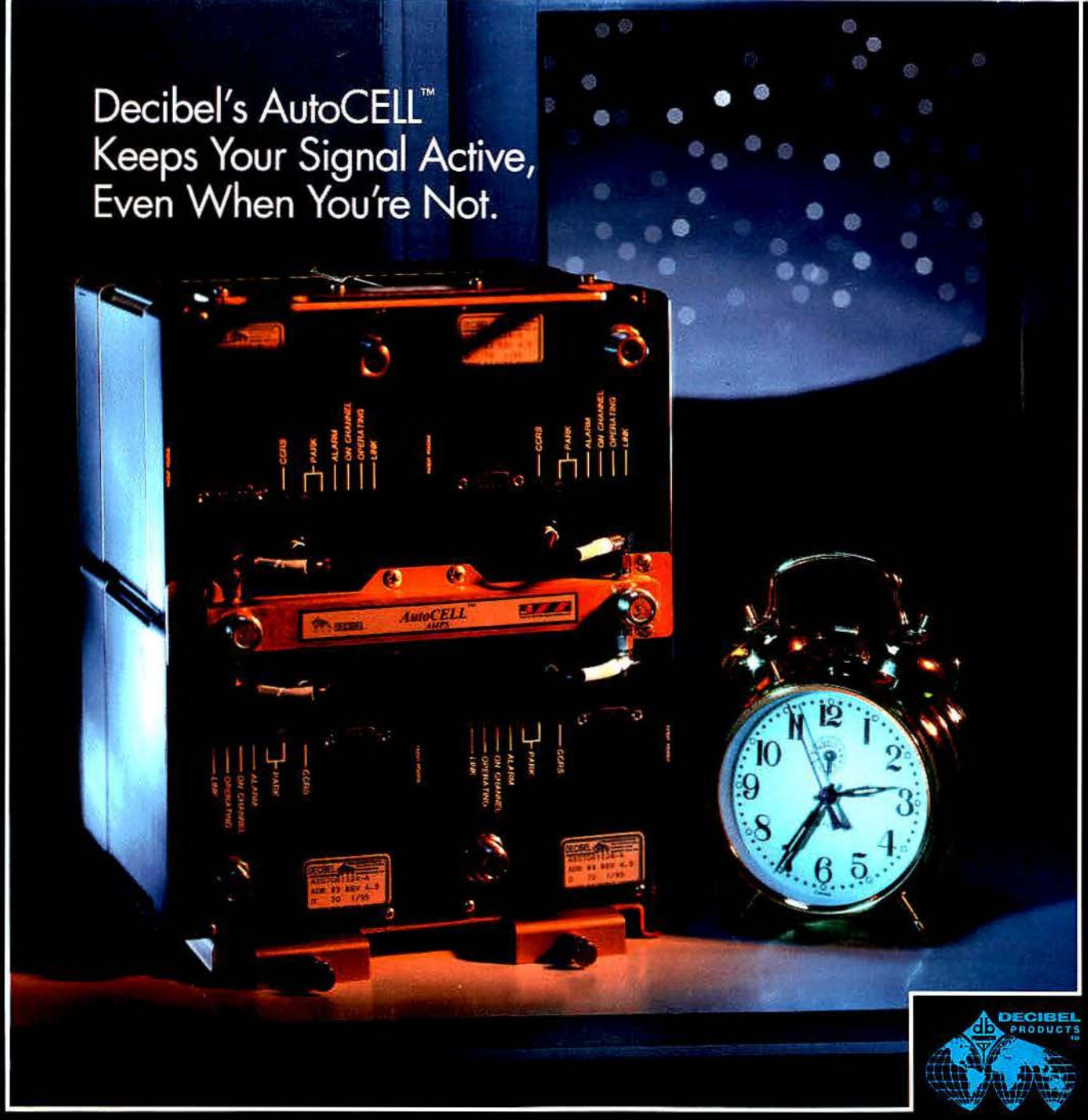
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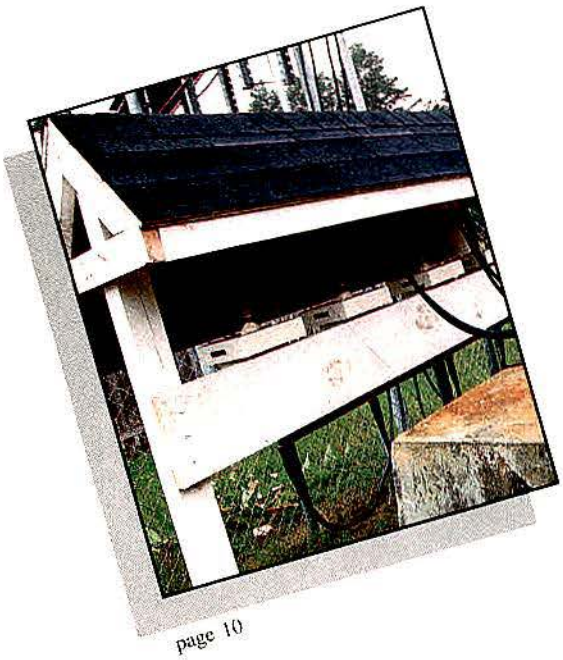
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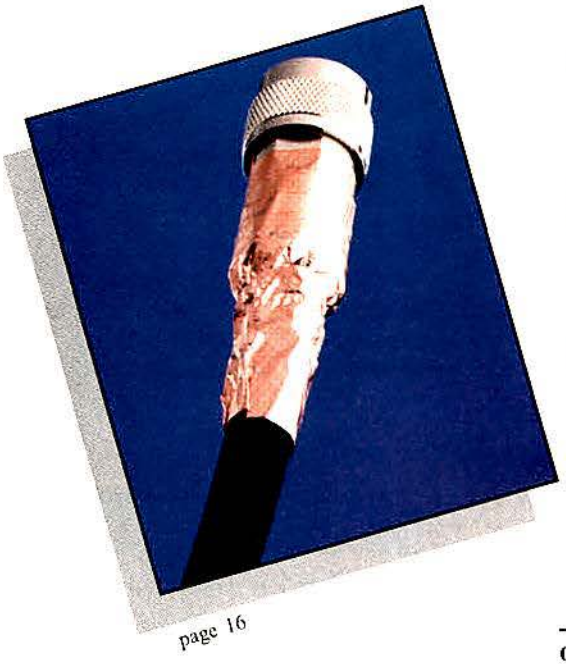
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On the cover: This 200-foot folded-unipole broadcast antenna tower supports nine UHF communications antennas. The ring distributes the AM broadcast energy to the six downleads in the unipole skirt.

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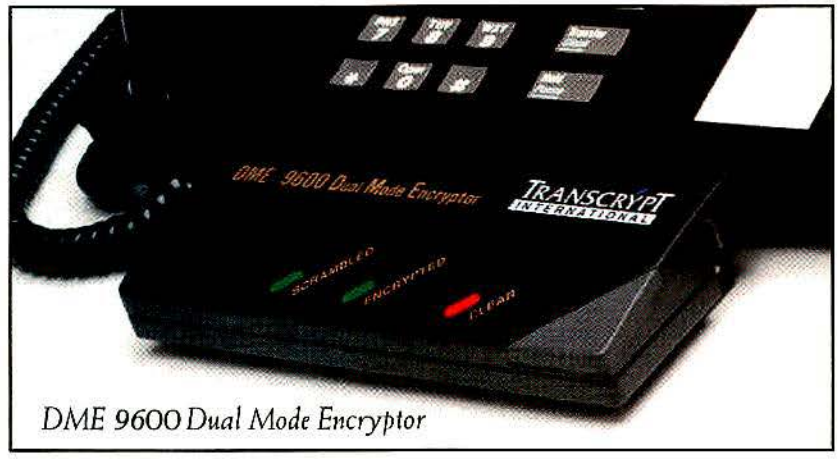
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All about towers, and visits in St. Louis



Towers

Growth in wireless communications requires more and more base station transmitter and receiver sites. Can you believe it? The FCC estimates that already there are about 500,000 antenna towers in the United States. About 70,000 of them that require obstruction marking and lighting might be among the more obvious towers, but still there are about a half-million antenna towers in use.

Sometimes existing towers can be used to support additional antennas. Sometimes new towers are necessary for growing conventional and trunked private wireless networks, SMR, ESMR, cellular, paging, narrowband PCS, wideband PCS and microwave communications. For work on new or existing towers, how do you find qualified tower workers? Should you hire a contractor? How do you make your selection, supervise the work and evaluate the results?

May 22–24 in St. Louis, we attended three days of classroom instruction about installing tower sites. "Foundations" was one of the first subjects to be covered. For example, the course taught how to order and how to interpret soil tests, what to expect in excavating a site, how steel reinforcement bars should be prepared, how to evaluate concrete quality to accept or reject concrete delivered to a site and how to cope with various weather-related problems.

"You'd be surprised how many mistakes are buried in foundations," said Ed Muehlfelt, one of the class instructors. Almost every foundation *looks* properly done at completion, but if the soil was not properly evaluated or if mistakes were made in surveying and excavating the hole, forming the volume to be poured, or mixing and reinforcing the concrete, tower life might be shortened by foundation defects that would be almost impossible to detect. The resulting damage to—or at worst, the collapse of—a tower is far less expensive to prevent than to remedy.

Safety, rigging, antennas, transmission lines, connector installation and weatherproofing, maintenance, electrical grounding and various compliances required by the Federal Communications Commission, the Federal Aviation Administration and the Occupational, Safety and Health Administration were among other topics covered in detail.

Organizations that own and use towers may not necessarily use their own employees to erect towers, to install equipment on them or to maintain the tower and the site, but knowing what is required for the best results makes it easier to order, to supervise and to evaluate the necessary work.

The course we attended is conducted by the Educational Services division of Broadcast Communications, New Glarus, WI. Because *MRT* emphasizes practical information, we chose the "Installing Tower Sites" course. "Managing Antenna Sites" offers similar information in a shorter course designed to help managers to select contractors and monitor their work. The division manager, Glenn A. Kramer, organizes the classes in various cities and teaches some of the subjects. Meuhlfelt is the company's senior applied engineer.

The "Installing Tower Sites" course also included hands-on instruction from a representative of Andrew Corporation's Heliax Institute, Orland Park, IL, about handling coaxial cable and waveguide connector installation and weatherproofing.

Many thanks to Broadcast Communications for the opportunity to attend the course.

Dispatch center visits

Susan L. Gallagher, corporate communications manager for Union Electric in St. Louis, made arrangements for us to visit the company's radio communications dispatch center. George A. Schindler, the company's supervising engineer, wrote a feature article about Union Electric's radio communications system for the June 1993 utility communications supplement issue.

Huge maps that display transmission and distribution grids often require rooms with ceilings several stories high at utility dispatch centers, and that makes for spacious working conditions. Union Electric is no exception. We'll show you a picture in a future issue.

Candice Green of the St. Louis Metropolitan Police Department's public information division arranged our visit there. Watch commander Ron Black showed us the dispatch facility, and lead technician Charles Esenberg showed us the repair facility. These facilities, which include a 20-channel, 800MHz trunked radio system, were constructed within the past few years, and they reflect careful planning and ongoing maintenance since their installation.

Sgt. Mark Dougherty of the St. Louis County Police gave us an opportunity to see the county's dispatching facility. The facility serves a huge area with a multisite VHF highband conventional simplex radio system.

Thanks to all of our hosts for making these visits possible.

Ranken Technical College

K.T. "Tom" Green Sr., the instructor of communications electronics and the communications manager for Ranken Technical College in St. Louis, showed us around school (and drove us to the county police department and to the airport—thanks!). The two-year communications electronics course includes radio and telephone equipment installation, maintenance and repair.

We met Tom several years ago when he joined the volunteer leadership council of the Association of Communications Technicians, a membership section of the Personal Communication Industry Association. He completed four years as council chairman in May.

With some of its facilities having been built in 1905–1907, Ranken boasts an attractive, uncrowded architecture that even includes a section of marble hallways. Communications electronics students use modern test equipment and radio and telephone equipment for practice. An endowment fund subsidizes tuition, and fundraising through the years has supported building renovations that keep Ranken looking fresh.

Ranken is a much better equipped and operated trade school than most that we've seen. Qualified radio communications technicians are in great demand, and for those who wonder where the new technicians are going to come from, Ranken is one of the sources. Ranken is smart to include telephone subjects in its communications electronics course, given the convergence of telephone and wireless technologies.

—Don Bishop

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Calendar

July

16-19—Forestry Conservation Communications Association, Edison Whalthall Hotel, Jackson, MS. Contact: Joyal Watkins, 601-354-6008.

26-28—Vehicular Technology Conference, sponsored by IEEE Vehicular Technology Society, Hyatt Regency Chicago O'Hare, Chicago. Contact: Keith Paglusch, chairman, 312-399-2378.

31-Aug. 4—Utilities Telecommunications Council, Hyatt Regency and Convention Center, Minneapolis. Contact: 202-872-0030.

August

13-18—Association of Public-Safety Communications Officials—International National Conference, Detroit. Contact: 800-949-2726.

September

20-23—Personal Communications Showcase, sponsored by the Personal Communications Industry Association (PCIA), Orange County Convention Center, Orlando, FL. Contact: 800-326-8638.

October

16-18—International Conference on Power Requirements for Mobile Computing and Wireless Communications, sponsored by BIS Strategic Decisions, Santa Clara Westin & Convention Center, Santa Clara, CA. Contact: 617-982-9500.

18-20—International Wireless Communications Expo/Fall has been canceled.

19-20—AMTEX, the American Mobile Telecommunications Association's Marketing and Technology Conference and Exposition, Hilton, Walt Disney World, Orlando, FL. Contact: 202-331-7773.

26—ERA Communications Trade Fair, Ala Moana Hotel, Honolulu. Contact: 310-287-1218.

29-Nov. 1—Wireless Apps, sponsored by the Cellular Telecommunications Industry Association, The Mirage Hotel, Las Vegas. Contact: 202-785-0081.

November

7-9—WirelessWorld Conference and Exposition, sponsored by *Cellular Business* and *Mobile Radio Technology* magazines, Moscone Convention Center, San Francisco. Contact: Chris Lotesto, 800-458-0479.

8-12—Communications Marketing Conference, sponsored by the Communications Marketing Association, Albuquerque, NM. Contact: Bernie Brownson, 303-371-8182.

17—Radio Club of America, Communications Symposium, 86th Anniversary Dinner and Awards Presentation, New York Athletic Club, New York. Contact: Ron Formella, 201-652-6811.

1996

March

23-25—Wireless '96, sponsored by the Cellular Telecommunications Industry Association, Dallas. Contact: 202-785-0081.

April

24-26—International Wireless Communications Expo/Spring, Las Vegas Convention Center, Las Vegas. Contact: 800-828-0420.

June

24-27—Supercomm, sponsored by USTA and TIA, Dallas Convention Center, Dallas. Contact: 202-326-7300.

July

11-13—Communications Expo/Show of the Americas, Miami, FL. Contact: 305-229-9992.

September

19-21—Personal Communications Showcase, sponsored by the Personal Communications Industry Association (PCIA), San Francisco. Contact: 800-326-8638.

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The journal of mobile communications technology

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Circle (7) on Fast Fact Card

Reflection coefficient and reflection angle ... what do they mean?

By Harold Kinley, C.E.T.

In radio electronics, there are many ways to express the same thing. *Reflection coefficient* is a way of expressing the degree of impedance match or mismatch between a load and a transmission line or between a transmission line and a generator. The angle associated with the reflection coefficient varies along a transmission line. The *angle* of the reflection coefficient, as well as the *amplitude* of the reflection coefficient, determines the *magnitude* of the standing wave at a particular point along a transmission line.

Reflection coefficient is normally represented by the Greek letter Γ (gamma).*

*Sometimes, reflection coefficient is represented by the Greek letter r (rho).

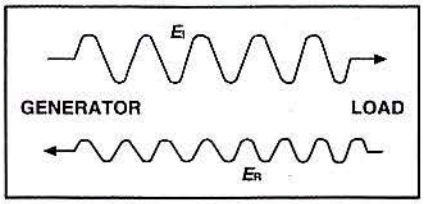


Figure 1. When a load is not properly matched to the transmission line, a reflected wave travels down the line in a direction opposite to the forward wave. The phase relationship of the two waves varies along the length of the line, repeating every half-wavelength. The resultant voltage depends on the magnitude and phase relationship between the two waves. When the two waves are in phase (0°), a voltage maximum occurs on the standing wave. Conversely, when the two waves are 180° out of phase, a voltage minimum occurs on the standing wave.

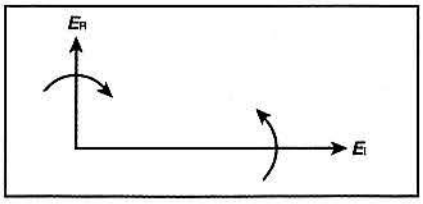


Figure 2. Two phasors represent the incident and reflected waves. The two phasors rotate in opposite directions at the same speed of rotation. This rotation causes variations in the amplitude of the *resultant* standing wave along the line.

Kinley, a certified electronics technician, is regional communications manager, South Carolina Forestry Commission, Spartanburg, SC. He is the author of *Standard Radio Communications Manual: With Instrumentation and Testing Techniques*, Prentice-Hall, 1985. He is a member of the Radio Club of America.

The VSWR (voltage standing wave ratio) can be determined from Γ by using Equation 1 in the box at the right.

When a transmission line terminates in an impedance (Z_L) that is not equal to the transmission line characteristic impedance (Z_O), a reflected wave appears on the line. The voltage of the reflected wave (E_R) will travel from the load toward the generator. This movement is opposite in direction to the forward or *incident* wave (E_I). (See Figure 1, below left.)

The phase relationship between E_I and E_R varies at different points along the line. This variation is represented by phasors in Figure 2, bottom left. As shown, E_I rotates counterclockwise, and E_R rotates clockwise. Each phasor rotates at the same speed but in an opposite direction. This difference causes the phasors to add and subtract according to the phase relationship between them at any given point.

Complex impedance mismatch

Consider a complex load of $20 - j80$ ohms connected to a 50Ω transmission line. How do we calculate the reflection coefficient and the angle of reflection? Use Equation 2. The calculations are shown in the box below. The load impedance (Z_L) must be entered in complex form. The magnitude of the numerator and denominator is then found by taking the square root of the sum of the squares of the *absolute values* (disregarding signs) of the *real* and *imaginary* components. The angles are determined from the tangents. For example, for the numerator the tangent is $-40/-15 = 2.666$.

$$VSWR = \frac{1+\Gamma}{1-\Gamma} \quad [1]$$

$$\Gamma = \frac{Z_L - Z_O}{Z_L + Z_O} \quad [2]$$

$$\phi = \theta - (720\lambda) \quad [3]$$

$$E = \sqrt{(\Gamma\cos\phi + 1)^2 + (\Gamma\sin\phi)^2} \quad [4]$$

$$Z_N = \frac{1+\Gamma}{1-\Gamma} \quad [5]$$

$$R_L = 20\log\Gamma \quad [6]$$

$$\%REF.POWER = 100\Gamma^2 \quad [7]$$

$\text{Tan}^{-1}(2.666) = 69.44°$. Figure 3 on page 72 shows that the result lies in the third quadrant, and so we must add 180° to 69.44° to get 249.44°. The denominator is calculated similarly to get a magnitude of 53.15 at an angle of −48.81°. Finally, the reflection coefficient (Γ) is calculated to be 0.8 at an angle of 298.25°, or simply −61.7°. This is the reflection coefficient (Γ) at the load.

To find the relative voltage level of the standing wave at the load, use Equation 4. This calculation gives us a factor of 1.55 at the load. This factor means that the combined voltage of the forward wave and the reflected wave at the load

(continued on page 72)

$$\frac{Z_L - Z_O}{Z_L + Z_O} = \frac{20 - j80 - 50}{20 - j80 + 50} = \frac{-30 - j80}{70 - j80} = \frac{2(-15 - j40)}{2(35 - j40)} = \frac{-15 - j40}{35 - j40}$$

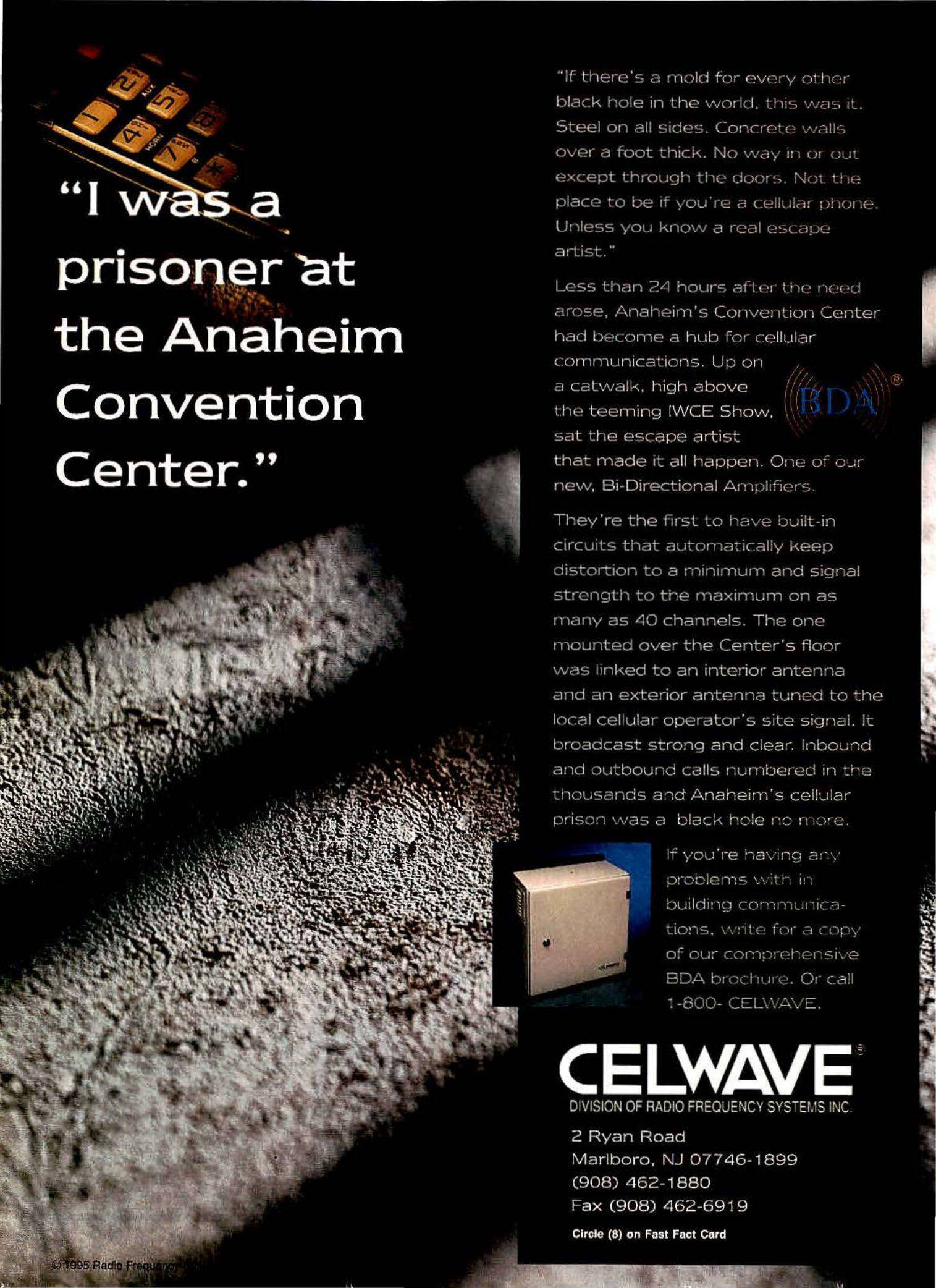
$$\tan^{-1}\left(\frac{-40}{-15}\right) = 69.4° \quad (69.4° + 180° = 249.4°)$$

$$\tan^{-1}\left(\frac{-40}{-35}\right) = -48.8°$$

$$Z_L - Z_O = \frac{40}{\sin 69.4°} = 42.7\angle 249.44°$$

$$Z_L + Z_O = \frac{40}{\sin 48.8°} = 53.2\angle -48.81°$$

$$\frac{42.7\angle 249.44°}{53.2\angle -48.81°} = 0.8\angle 298.3° = 0.8\angle -61.7°$$



"I was a prisoner at the Anaheim Convention Center."

"If there's a mold for every other black hole in the world, this was it. Steel on all sides. Concrete walls over a foot thick. No way in or out except through the doors. Not the place to be if you're a cellular phone. Unless you know a real escape artist."

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If you're having any problems with in building communications, write for a copy of our comprehensive BDA brochure. Or call 1-800- CELWAVE.

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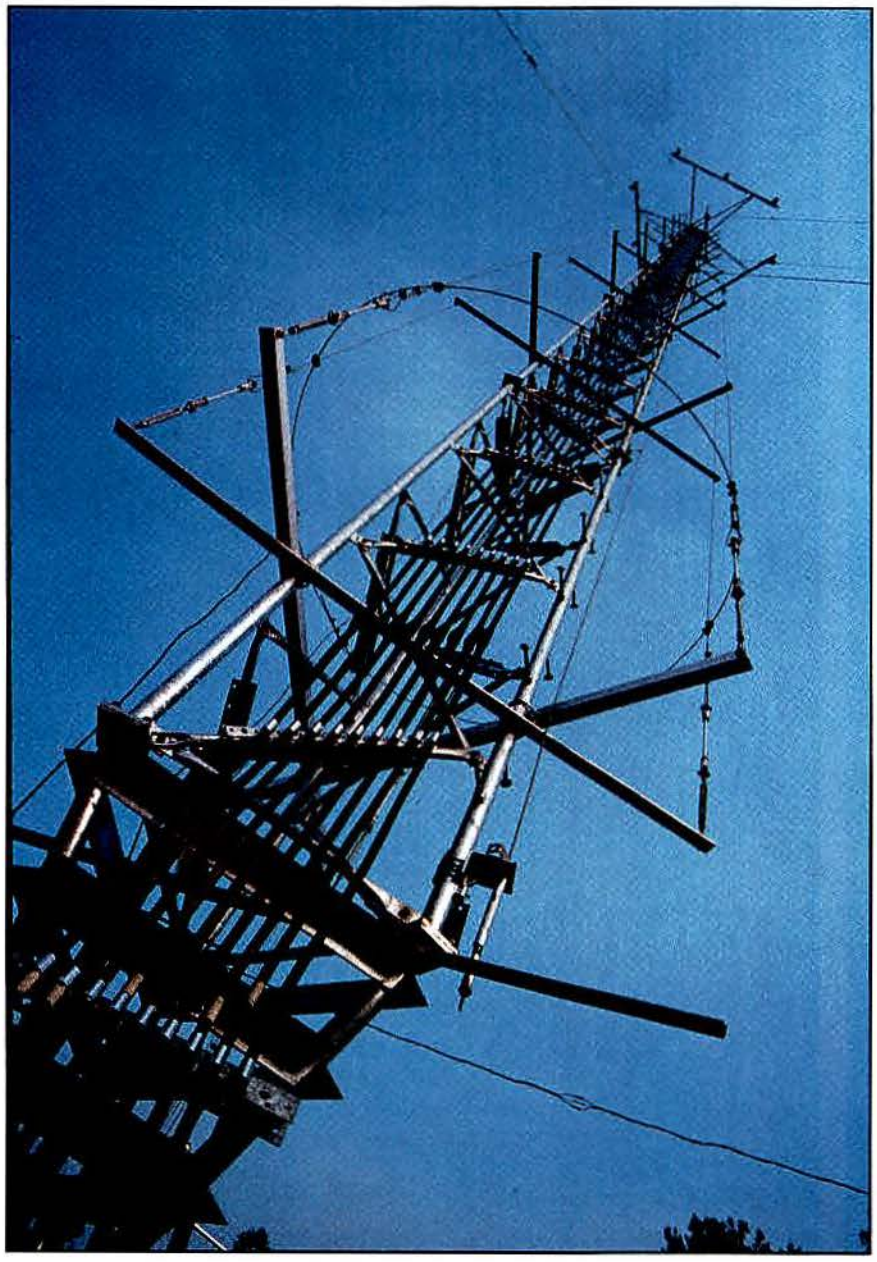
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Use AM broadcast towers to hold base station antennas

When searching for your next base station site, check out the AM broadcast stations in the vicinity. Using an AM station tower at a suitable location might save a substantial amount of time and money.



This 200-foot folded-unipole broadcast antenna tower supports nine UHF communications antennas. The ring distributes the AM broadcast energy to the six downleads in the unipole skirt.

By William A. Culpepper, P.E.

Finding sites for communications antennas grows more difficult every day. Zoning restrictions at prospective tower and rooftop sites and congested antenna installations at already developed sites make it difficult to place some new antennas at or near the best location for the desired wireless communications system coverage.

Existing AM radio broadcast towers can be technically and financially attractive for use as communications antenna supporting structures.

Compatibility problem

When installed on an AM broadcast tower, a base station antenna's primary electrical requirement involves coupling VHF or UHF signals onto the tower without disturbing the broadcast signal. In AM broadcasting, the tower is the actual RF energy radiator, and two methods are used to feed power to the tower. The most common is *series feed*, in which the tower is supported by a large base insulator, and power is fed directly to the tower base.

The second method is *shunt feed*, in which the tower base is at ground potential, and power is fed to the tower by means of several vertical wires suspended from a point at a substantial height above the tower base. The wires are electrically connected to the tower at some point. They

Culpepper is a principal with William Culpepper & Associates, consulting communications engineers, Charlotte, NC. He is a member of the Association of Federal Communications Consulting Engineers. © 1994 by William A. Culpepper, P.E.

generally are spaced two to four feet from the tower. This system of wires is referred to as a *skirt*, and the antenna is called a *folded unipole*. Its function resembles that of a gamma match on a yagi antenna's driven element.

A second shunt system is called a *slant wire* feed. These systems were popular in the 1930s and 1940s, but they are rarely used anymore.

In the series-fed system, the entire tower is "hot" with RF, and the base voltage is a function of the antenna impedance and the station power. With 100% modulation, voltage can vary from less than 1,000V on a 250W station to more than 30,000V on a 50kW station with a moderately high-impedance antenna.

With a shunt-fed antenna, the tower base is at ground potential, and the communications transmission lines can pass from the horizontal cable tray directly to the broadcast tower with minimal problems. The base of a series-fed AM broadcast tower is at high RF potential relative to ground, and special measures must be taken to attach the communications transmission lines, which are at ground potential.

Solutions

There are three solutions to the problem of attaching transmission lines to series-fed broadcast towers:

(1) An *isocoupler* can be used in the transmission lines.

(2) The transmission lines can be insulated from the tower for the bottom quarter-wavelength of the tower (assuming that the tower is at least one-quarter wavelength high).

(3) The antenna can be converted to a folded unipole.

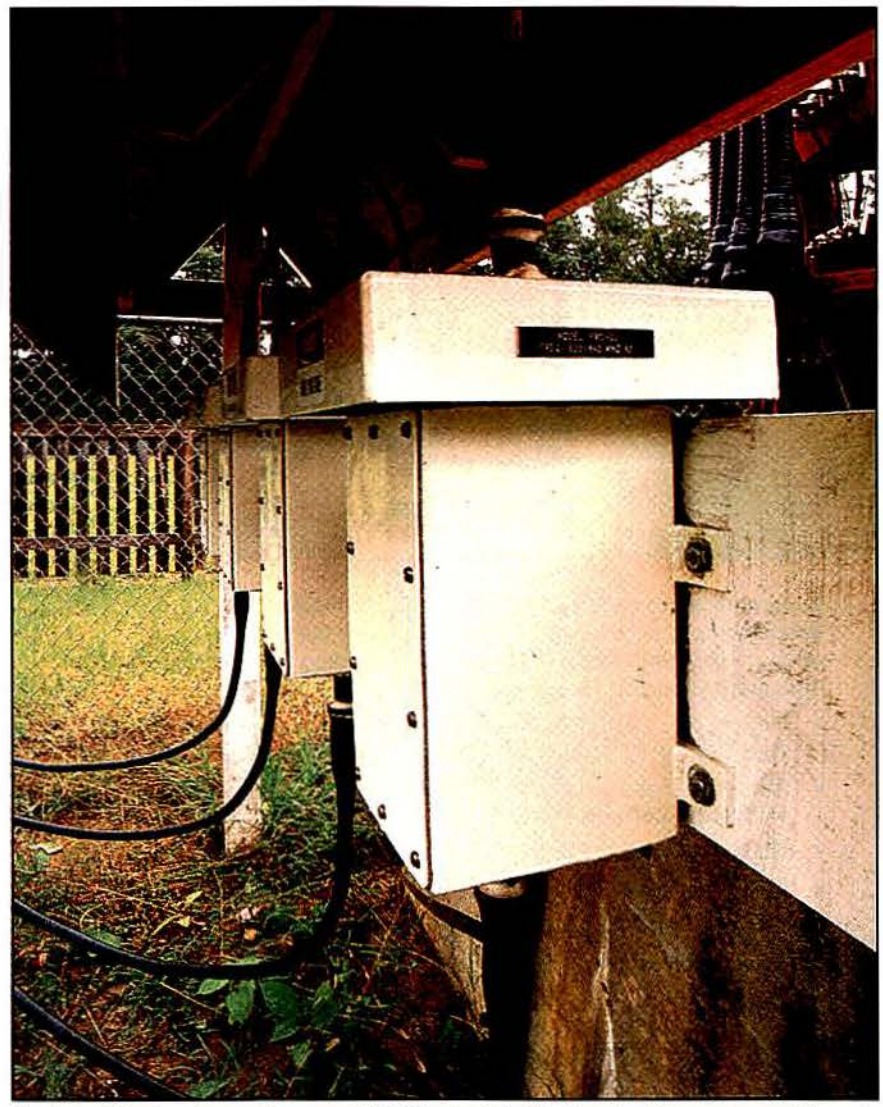
The isocoupler causes the least disturbance to the broadcast tower. Potential problems with isocouplers include the additional loss that they introduce into the communications transmission lines, the shunt capacity that multiple couplers add to the AM tower and the need for custom-made couplers on certain high-power broadcast stations.

The insulated quarterwave section adds no additional loss to the communications transmission lines, and it can handle high AM broadcast powers. It affects the AM system bandwidth and causes a small amount of distortion in the antenna pattern of the broadcast station, but neither of these effects should cause a serious problem. The insulated quarterwave section requires insulated cable hangers, and the insulators must be designed for the appropriate mechanical and electrical stress.

In some cases, the most advantageous approach to achieving compatibility is to



The base of a series-fed tower shows the base insulator and the tops of four UHF communications isocouplers underneath the rain and ice shield.



The tops of the four isocouplers are at high RF potential at the broadcast frequency, and the main boxes are at ground potential. The lower coaxial cables lead to the cable tray and into the equipment shelter.

convert the broadcast antenna to a folded unipole. Special attention should be given to the design of a unipole skirt for a tower greater than 0.35-wavelength at the broadcast frequency to avoid a reduction in radiation efficiency.

Regardless of which method is used to achieve the required compatibility, communications company employees should be aware that an active AM broadcast tower is surrounded by high RF electric and magnetic fields or *non-ionizing radio frequency radiation* (RFR). Adequate protective measures should be taken, and warning signs should be posted to protect employees and to satisfy the requirements of the FCC and the Occupational Safety and Health Administration (OSHA). Areas with high RF radiation generally are contained within the fence around the AM tower.

In connection with the RFR problem and

AM broadcast tower advantages

- ☐ *Location* — The AM broadcast tower may be where a site is needed.
- ☐ *Zoning* — Local governmental zoning problems can be eliminated or reduced.
- ☐ *Costs* — Lease payments can be substantially less than the amount required to amortize the cost of the land and tower.
- ☐ *Ground system* — Most AM broadcast towers have a superb ground system consisting of 120 buried wires emanating from the tower base for 150 feet or more and spaced at three degree intervals. This system can be used to enhance the quality of the base-station protective ground, particularly in sandy soil.
- ☐ *Nondirectional AM* — Antenna installation on a nondirectional AM broadcast tower does not require pre- and post-construction field strength measurements for the AM station, nor does it require the installation, adjustment and maintenance of a detuning system on a new communications tower. When a new tower is built within one-half mile of a nondirectional AM station, "before" and "after" measurements are required, and detuning might be required. Reusing the AM tower instead would save a substantial amount of money.
- ☐ *Directional AM* — Protection of directional AM stations is similar to that of nondirectional AM stations, except that the protection zone extends for two miles instead of a half mile. Using one tower in a directional system eliminates the requirement for the "before" field strength measurements and the detuning apparatus; nevertheless, it still will require post-construction field strength measurements. (A decision to use a tower in a directional AM system should be made only with the advice of the broadcast station's consulting engineer and the communications company's consulting engineer.)

AM broadcast tower disadvantages

- ☐ *Tower strengthening* — The addition of transmission lines, antennas and related hardware might require modification or replacement of the tower, guy wires or both.
- ☐ *Liability* — The FCC holds tower owners and all tower tenants jointly responsible for any required aviation obstructing marking and lighting. A pending FCC Notice of Proposed Rulemaking, if enacted, would make only the tower owner liable.

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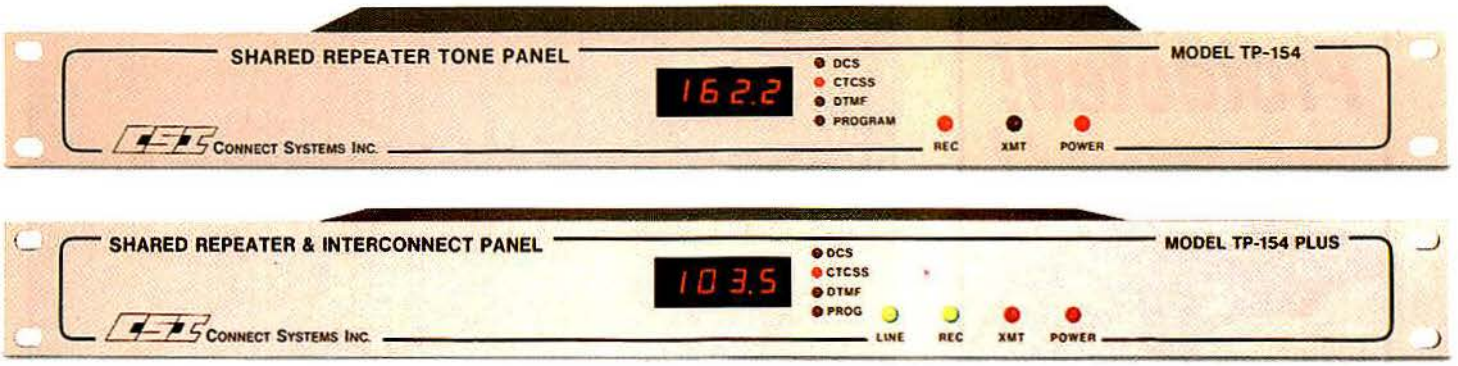
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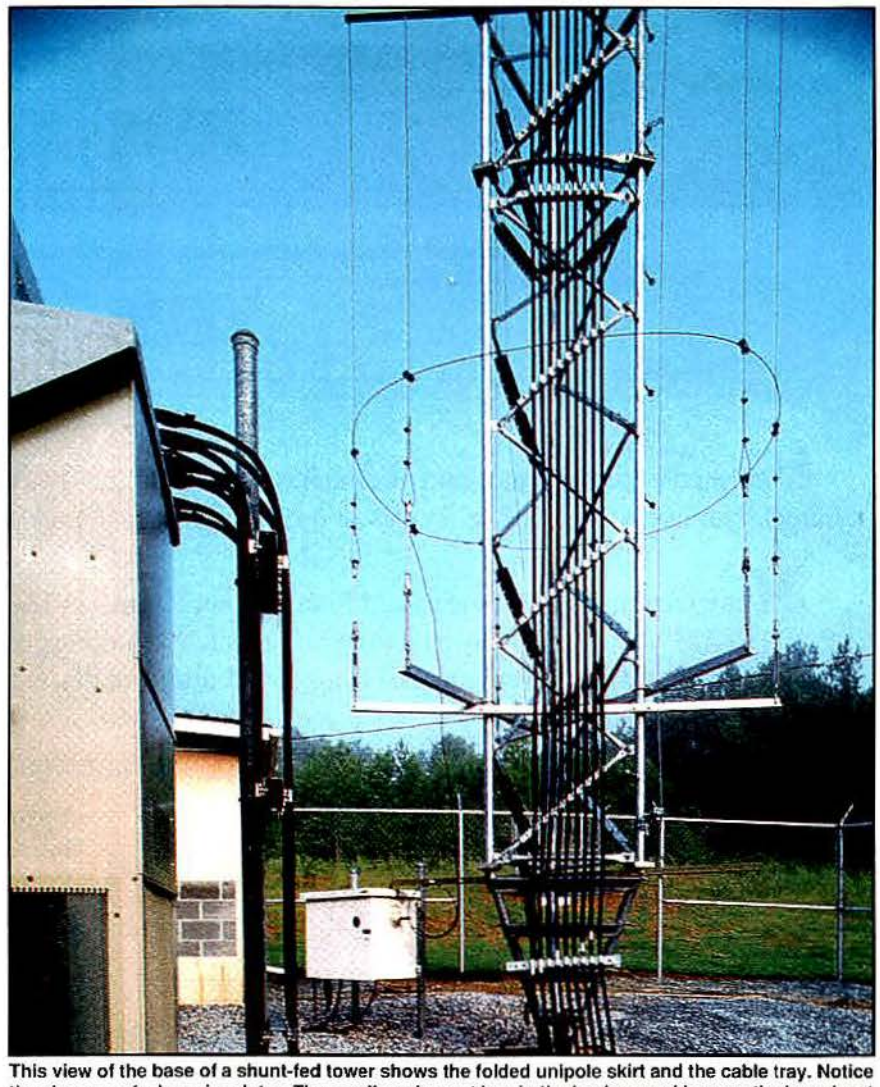
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This view of the base of a shunt-fed tower shows the folded unipole skirt and the cable tray. Notice the absence of a base insulator. The small equipment box in the background houses the broadcast antenna impedance-matching network.

as part of the formal agreement to share the tower, arrangements should be made with broadcast station owners to turn the AM transmitter off or to reduce its power during communications equipment installation or maintenance conducted on or near the tower. If there are FM broadcast or communications antennas on the tower, the planners should be aware of the implications of any RFR hazard that might be associated with such antennas and make contractural provisions for FCC and OSHA compliance.

If structural considerations require adding or modifying tower guy wires, they must be segmented with insulators at intervals of approximately 0.1 wavelength. Special attention should be given to the insulators where the wires attach to the tower.

It is likely that all of these potential problems can be dealt with effectively and economically. If you encounter what appears to be an insurmountable technical problem, seek a second opinion before eliminating the AM station as a candidate for your new site.

I have been involved in the installation of cellular antenna systems on both series-fed and shunt-fed AM broadcast towers. In all cases, there was complete compatibility between the mobile telephone system and the broadcast station. The owners and managers of both were happy. The cellular telephone company acquired a site where it was needed—with minimal permit problems and a lower cost than for a stand-alone site—and the broadcast station established a valuable income stream that should continue for many years.

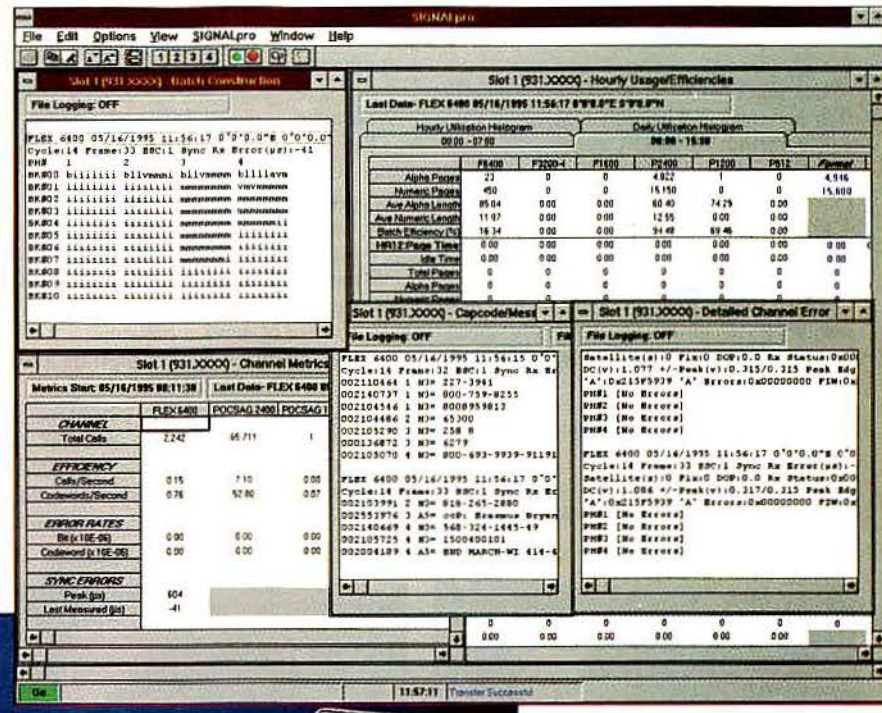
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- Detailed channel error display provides real time bit error analysis and determination of the peak edge misalignment
- Synchronous receive time information provides error analysis of FLEX transmission boundaries





- Channel metrics display summarizes critical data such as bit error rate, codeword error rate, and channel call rates for each format and data rate
- Hourly Usage/Efficiencies display provides detailed information about average message length, batch efficiencies per format and data rate, channel utilization, and more
- Internal GPS receiver option
- Capcode/Message summary can be filtered by capcode(s) and by words, message fragments, character combinations, etc.

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EMI/RFI survival strategies

Use avoidance, attenuation and isolation as part of your installation tool box, stopping problems before they cost time or money. Customers will be impressed with the results, and there will be fewer callbacks.

By Donald E. Koehler

Certain EMI/RFI* strategies, installation practices and hazards may result from using certain EMI/RFI cures.

My previous article ("Two Case Histories Of EMI/RFI Solutions," July 1994) explains problems with EMI/RFI interactions. I will refer to these as problems of electromagnetic compatibility (EMC).

Three broad areas of action can help to resolve EMC problems. Generally speaking, EMC can be enhanced by *avoidance*, *attenuation* and *isolation*. Any or a combination of these may be necessary to eliminate EMC problems with installed equipment.

*Electromagnetic interference/radio frequency interference.

Koehler is the owner of Communication Specialties, Anchorage, AK.

Avoidance

The least expensive of these strategies may be avoidance.

Avoidance covers four main steps, including:

- ☐ a pre-installation check of the area.
- ☐ the use of commercial software to find harmonic "hits."
- ☐ the use of service bulletins.
- ☐ the selection of appropriate power levels for the intended use.

Each of these steps has advantages for the service technician or installer. Although they are not necessarily listed in order of importance, these steps should be followed first during installation planning and practice.





Shielding tapes are shown as applied to connectors on RG 8/U coaxial cable. ***(Adhesives Research photos.)***



Flexible metallized fabric shielding tapes can be used for 60dB+ shielding as a tape or cable wrap. ***(Adhesives Research photo.)***

▶ *Pre-installation checks*—As was mentioned in "Two Case Histories," a broadband, high-speed scanner can be effective in identifying potential sources of EMC problems. Using a scanner before beginning an installation can save time, money, callouts and possibly an unhappy customer. I use scanners in two ways in a pre-installation check.

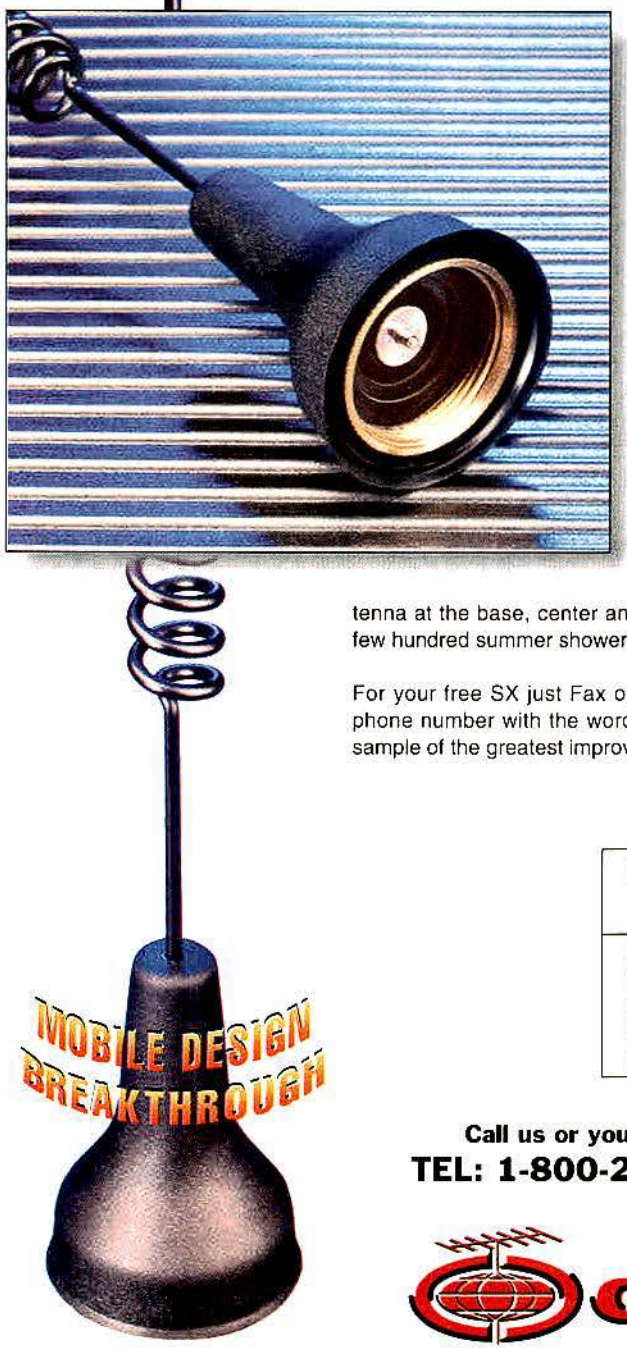
First, load all of the customer's channel frequencies into the scanner. Then, with the vehicle (or other installation site) operating normally, let the scanner run.

Listen for "hits," or incompatibilities, on the channels loaded into the scanner. The hit may sound like static, a whistle or a rough buzz.

Open the vehicle's hood, then carefully move the scanner's antenna near the battery and any of the installed "black boxes" such as the fuel injection computer. Do the same on the inside of the vehicle. Activate the heater and other accessories at this time.

If no noise is heard on the scanner, switch it to *search mode* and set the search limits to just above and below the range of frequencies proposed for use in the installed equipment. Most modern scanners cover 100kHz to 2.0GHz, and they are more than useful for this purpose.

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Photo 1. Various types of ferrite components are available to suppress conducted electromagnetic interference. *(Fair-Rite Products photo.)*

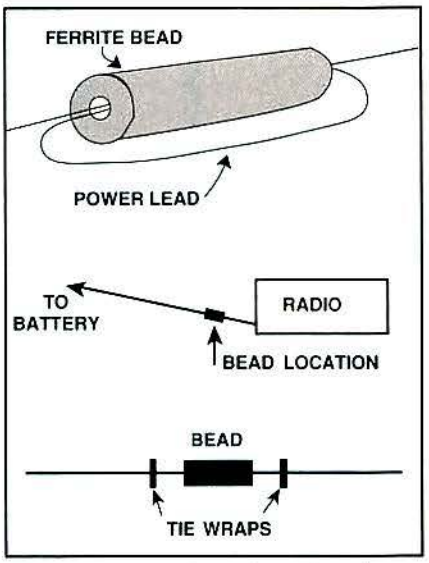


Figure 1. Ferrite beads used to reduce electromagnetic interference can be held in place either by looping the power lead through the bead or by placing tie wraps on either side of the bead.

▶ *Commercial software*—Note frequencies where the hits occur and see whether they are the same as, or harmonically related to, the planned frequencies. Using commercial software to check harmonic relationships among installed frequencies and others that may be used in the future will save a lot of grief later. Harmonic relationships can be hard to discern, but the problems they may cause are real indeed.

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Applications

- Use with any Scanner or Receiver for Off-The-Air measurements (may require internal connection to discriminator for CTCSS and DCS)
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software is powerful enough to keep you out of trouble. Checking harmonic relationships has limited benefit for the first installation technician to work on the vehicle, but it pays dividends during retrofits. Take a minute to run these software checks before installing new equipment into systems or vehicles where communications equipment is already in use.

▶ *Service bulletins* — If you can take a few moments to look through equipment service bulletins before installation, you may save time.

Look for warnings on minimum equipment clearances, grounding and power requirements, antenna or power cabling restrictions and other information that may affect the planned installation.

▶ *Power levels* — Finally, use the *least* amount of power necessary for the job.

Modern radio sets have computer-controlled-and-set wideband frequency and power settings. Never use more power than is called for in the installation package. Excess power can cause EMC problems or receiver desensitization (desense) in other installed equipment. In this case, the old saying "If a little is good, gobs is great" doesn't help matters.

Attenuation

The issue of power output brings us to the next of the major strategies, attenuation.

When EMC problems arise, experienced technicians try to attenuate the interfering signal. This attenuation may take many forms.

Typically, attenuation is applied via RF and IF filters. Cavity filters, crystal filters and the alternative of relocating antennas can be considered as "attenuators."

One often-overlooked alternative EMC filter is a ferrite bead used on power leads and occasionally on RF cables. Secure these ferrite beads with glue or wraps to prevent damage to the bead caused by movement. (See Figure 1 and Photo 1 on page 18.)

Bypass capacitors on power leads or power sources offer a low-impedance path-to-ground for incompatible signals.

Isolation

Communications equipment can be shielded and bonded, and its ac or dc supply current can be filtered to isolate it from incompatible signals. The shielding may take the form of conductive foils, tubes made of conductive or attenuating material, conductive caulks or conductive tapes.

When using these conductive shields, take extreme care to ensure that the material will not come loose and short out other equipment. The idea of the shielding is to conduct the incompatible signal away from your equipment and to provide a low-impedance path to ground.

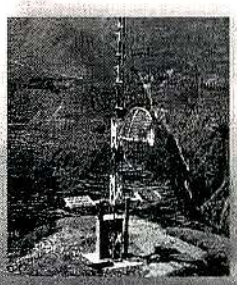
Another way to prevent the entry of an incompatible signal is to bond all equipment to ground properly. New vehicles make extensive use of plastics, and exposed vehicular metal often is coated with anti-rust compounds that insulate what may appear to be a properly bonded connection.

Bonding can take several forms. Using conductive strapping to tie together both the radio equipment and the mounts to the vehicle frame is a good, low-cost start. Further work to tie the vehicle body, frame and negative battery terminals into one circuit may reduce background noise.

Care must be taken with special-purpose vehicles such as refueling tankers and hazardous materials (hazmat) transports.

The most common type of refueling tankers has extensive grounding and bond-

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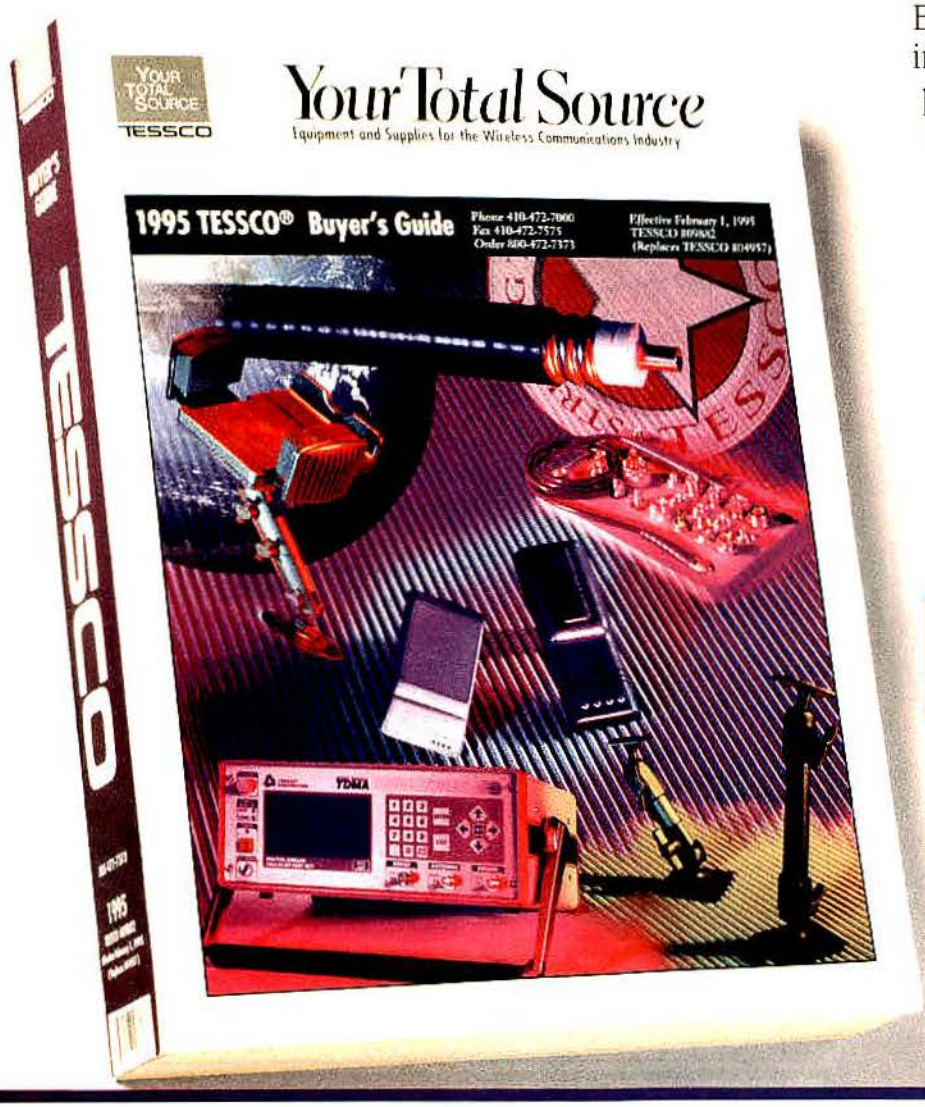
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Circle (17) on Fast Fact Card

EMI gasket considerations

When a metal box has a cover, the flowing current meets resistance at the joint between the cover and the chassis. This resistance creates a voltage differential across the joint, which acts as another antenna. This "joint antenna" will radiate a secondary electromagnetic field either into your box (susceptibility) or out of your box (emissions), depending on whether the source of the EMI wave is outside or inside your box. (See Figures A and B below.) It is this secondary electromagnetic field that is the "EMI" that "leaks" out of joints.

Short of welding the box shut, you cannot completely get rid of the "joint antenna" and EMI "leakage," but you can minimize it. There are only two parts to the equation: Either you minimize the current flow (usually uncontrollable), or you must minimize the joint's impedance. A highly conductive EMI gasket paired with the right joint surface restores the continuity between the cover and the chassis, thus minimizing the joint's impedance and reducing EMI. (See Figure C below.)

Fortunately, radio frequency interference is at a relatively low electromagnetic frequency and can be controlled easily with a variety of EMI gaskets. EMI gaskets can be surface-mounted or groove-mounted, and some can be retrofit. Most are best used when designed into equipment from the start. Generally, you should look for a highly conductive gasket because the conductivity of the gasketed joint is what reduces EMI.

EMI gaskets come in many configurations, including spiral-wound, fingerstock, conductive elastomers, springs, mesh and conductive gaskets. (See Photos D and E below.) All of these gaskets have advantages and disadvantages depending on the application.

—Bonnie A. Kunkel, Spira

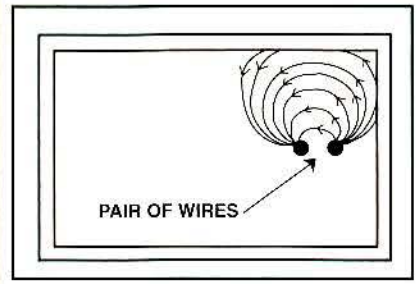


Figure A. Any pair of wires carrying current causes an electromagnetic field to radiate. When that field strikes the box, it causes a current to flow.

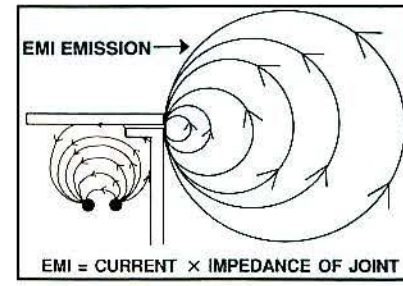


Figure B. The voltage differential between the cover and the chassis causes another electromagnetic field to radiate. The secondary field is 'EMI.'

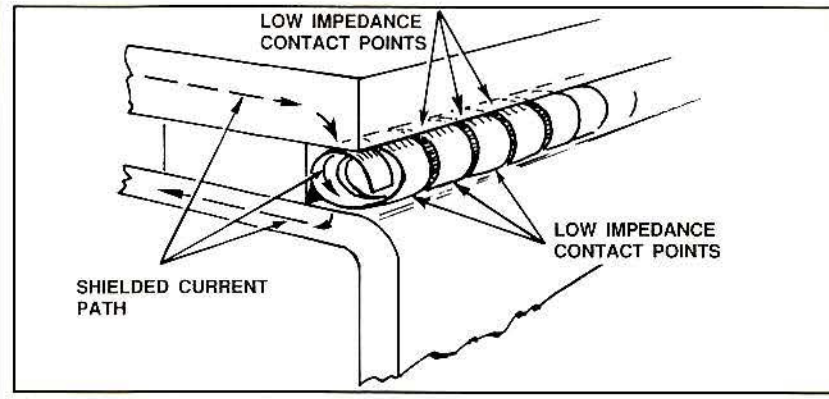
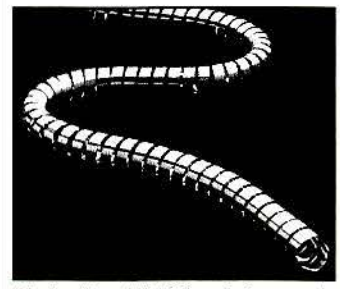
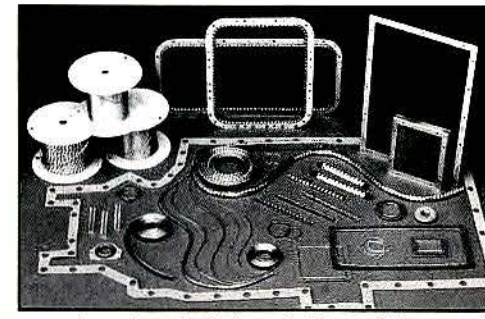


Figure C. A highly conductive EMI gasket paired with the right joint surface restores the continuity between the cover and the chassis, thus minimizing the joint's impedance and reducing EMI.



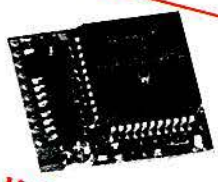


Photos D and E. EMI gaskets come in many configurations, including spiral-wound, fingerstock, conductive elastomers, springs, mesh and conductive gaskets. All of these gaskets have advantages and disadvantages depending on the application. *(Spira photos.)*

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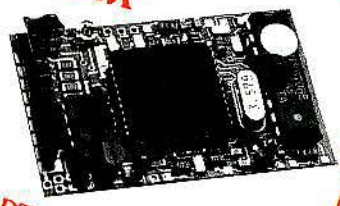
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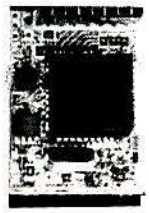
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Circle (18) on Fast Fact Card

Using EMI/RFI shielded enclosures

When coax penetrations are to be taken through a shielded wall, they must be properly terminated via bulkhead. Periodically, users will make the mistake of running coax cable through a waveguide feed through pipe or simply a drilled hole, which destroys the shielding effectiveness of the enclosure.

The importance of good grounding cannot be overemphasized. Make certain that safety grounds are in place and that RF grounds for both shielded areas and the equipment are not resonant at the frequency of interference.

In those cases involving servicing of scanners, pagers, and cellular phones, very often a system operator will chose to service mobile or portable equipment at the operating site and underestimate the amount of attenuation required. Within the shielded room, technicians may conclude that the shield is not working properly when a receiver can still hear a transmitter external to the shield. We suggest that customers conduct a site RF survey at the intended shield room location to determine the RF level required. Many modern receivers are so sensitive that even 100dB to 120dB of shielding effectiveness is not adequate when the external RF field is at 0dBm.
—William E. Curran, Lindgren RF Enclosures

ing systems, most of which are electrically isolated from the ignition system. All of the fuel trucks I have worked on were diesel-powered to eliminate sparks from the engine. The pumps run from a power take-off (PTO) driven from the transmission by hydraulic power.

Perversely, these trucks usually do not have intrinsically safe radios. The drivers are told to turn the radios off before approaching the aircraft.

Hazmat trucks use a variety of methods to pick up spilled material, with a vacuum system being the most common. To bleed off static charges, the vehicle is grounded through a large resistor network. Any improperly installed radio could provide a ground path around this "bleeder" resistor network. As always, a check with the vehicle service manual, operator or both should be mandatory for installers.

The installer faces exposure to hazardous materials, and sparks are dangerous. I use an air-powered drill around these vehicles.

Power leads

When routing power leads, make them as short as possible, and use the proper gauge of wire.

Ac and dc filters such as chokes and capacitors help to keep "hash," or wideband noise, out of equipment.

Now let's apply this information into some installation practices.

When first planning the installation of communications equipment in a vehicle, take a moment to "sweep" the area with a scanner. This sweep should show potential sources affecting EMC.

Incompatibility sources typically are found near vehicle black boxes, digital dashes and other displays with multiplex drivers. Once interference sources are identified, route the power and RF cables away from the source. If the cable routing does not allow for avoidance, shielding may be required.

Flexible, conductive tapes, conductive caulks or foils can be used to cover the cabling that passes near an incompatibility source. Technicians can fabricate short lengths of cable with this cover in the field.

Conductive tapes, foils or, in a pinch, the outer conductor from a length of coaxial cable usually will fix these EMC problems. Grounding the cover material usually is not necessary. Each application

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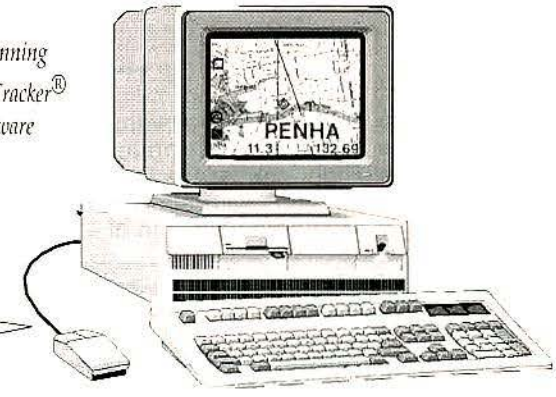
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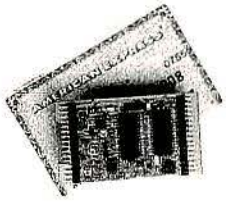


The mobile receives signals from GPS satellites.

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The vehicle ID, speed and direction are sent to the base display



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Circle (20) on Fast Fact Card

is unique. Use common sense when placing conductive materials near power sources.

Covering conductive materials with insulating tape will not impair the material's shielding properties.

Taking time to bond the radio, the mount and the vehicle body together can eliminate wideband noise sources. When installing mobile computing equipment, this step may become even more important, because this equipment often generates large amounts of wideband digital noise.

Use care to bond the interconnecting cables and connectors. Ensure solid ground paths by sanding the area around the "ground" connecting fastener.

The use of modern anti-rust compounds can impair or raise the ground-path impedance. To protect the ground connection and fastener, use conductive caulks or grease. Small amounts of conductive caulks under mount "fingers" may improve the grounding of blind-mount antennas when you are installing equipment in special-purpose vehicles or in humid climates.

I always have used a pair of stiff, trailing ground straps for runway vacuum trucks. When in operation, these vacuum trucks suffer from static generated by the movement of dust and sand through the system, so attention to bonding is essential. City sweeper crews and commercial parking lot cleaning providers may face the same problem.

As always, when installing equipment in special-purpose vehicles, take the time to read both equipment and vehicle technical data. I have had good luck with these "rule of thumb" procedures when installing radio equipment in vehicles as diverse as aircraft fueling trucks, snowplows, forklifts and fire trucks. If you have questions, talk to the vehicle service personnel or vehicle dealer.

Even the best-planned installations can generate hazardous conditions.

Hazardous conditions

Even the best-planned installations can generate hazardous conditions. Let's look at some of those conditions.

When using conductive materials for attenuation or shielding, be careful! These materials may become "conductors of opportunity" or part of "sneak circuits" not protected by fuses.

To guard against this hazard, fuse both power leads as close to the battery as possible. Ensure that conductors are protected from chafe and movement.

Take a moment to mark the vehicle service record on location and the reason for using the conductive materials. Before you install trailing ground straps, check with the operator to ensure that the ground path they create will not violate any safety restrictions. This step is critical on HAZMAT and some fuel transporters. If you are in doubt or the operator is unsure, call the local or state department of transportation to double-check.

Foils used for shielding can cause heat buildup. Before using foil as shielding material, ensure that its placement will not violate the vehicle warranty. After installation, check all vehicle systems and ac-

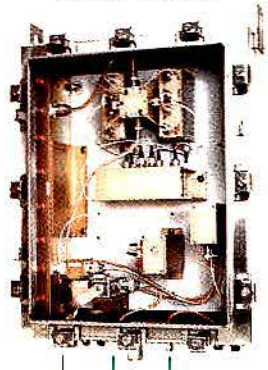
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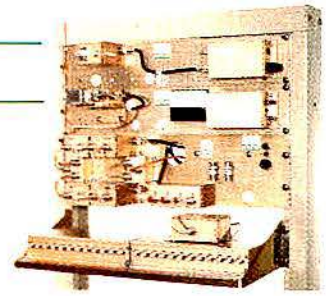
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Scott Howes, Word Perfect Corporation, Orem UT



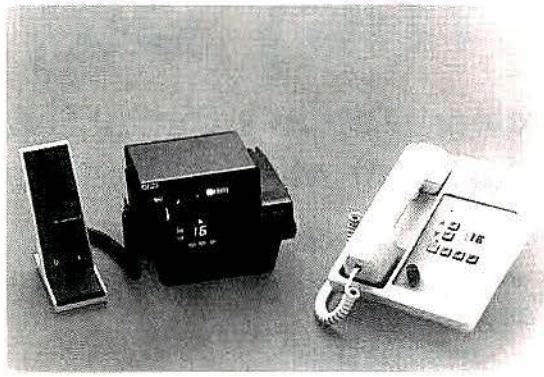
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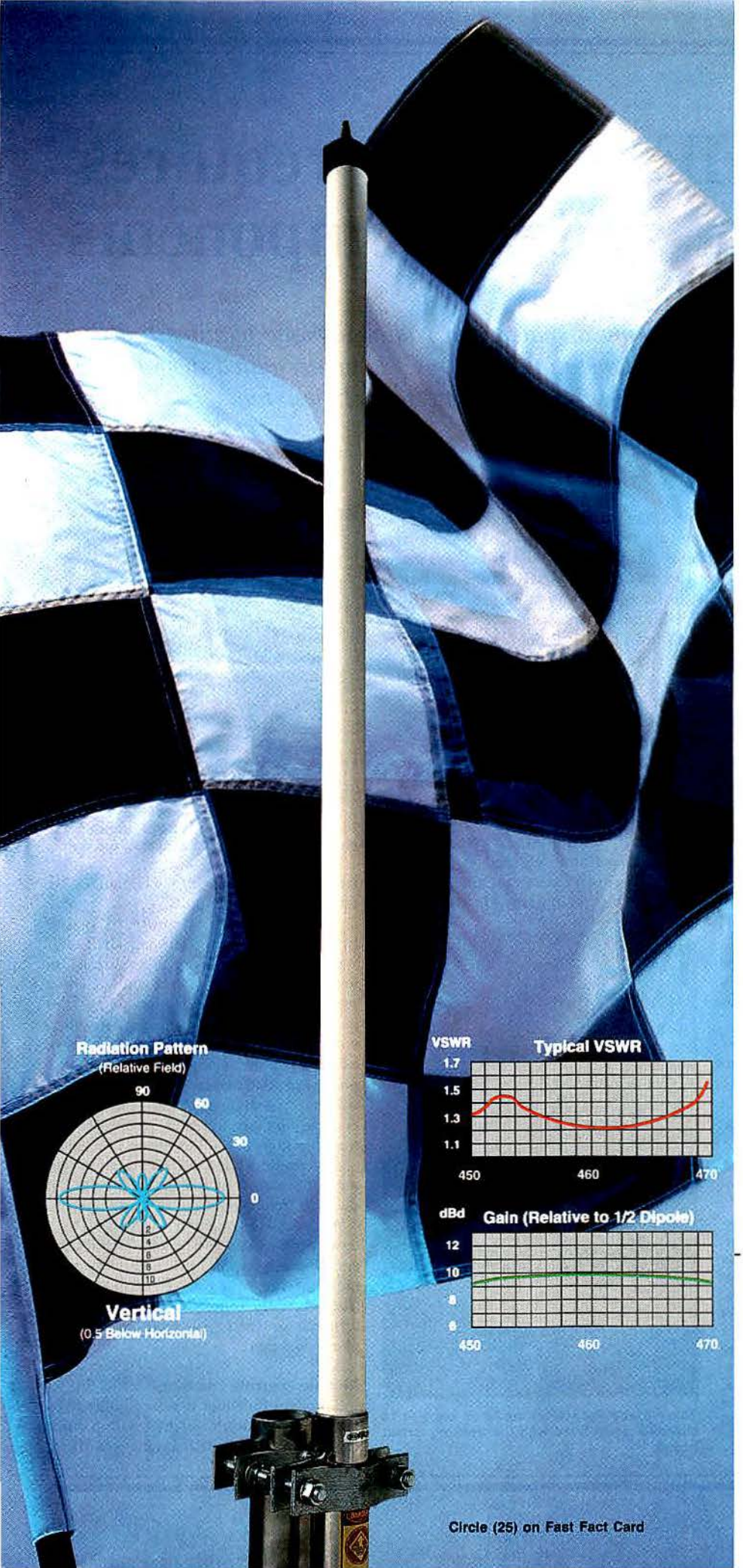
cessories with the installed equipment transmitting. Imagine how dangerous it would be if your transmitter caused a vehicle anti-locking brake system or fuel injection system to fail.

Although these types of problems are rare, it only takes a moment to check EMC interactions with the vehicle systems after the installation is complete. After all, if you did not install the vehicle alarm, cellular phone or stereo equipment, you must be sure that these common systems do not cause problems for each other.

Plan to use *avoidance*, *attenuation* and *isolation* as part of your installation tool box, stopping problems before they cost time or money. Customers will be impressed with your professionalism, and the boss will be happy because of fewer callbacks.

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By William J. Scott and Chuck Soulliard

Radio trunking technology was originally developed to improve spectrum efficiency. Improving spectrum efficiency means making it possible for more people to use communications devices (or to carry greater quantities of information) on a given bandwidth of radio frequencies, and trunking means the automatic selection of a clear channel from a pool of channels shared by many users. With several channels from which to select, it is more likely to find a clear one at a given moment than it is to find a clear channel when only a single channel is shared, even with the same proportion of users. For example, it is more likely to find an open channel with 500 users sharing five trunked channels than with 100 users sharing one channel.

Trunking was introduced for use in the 800MHz band in the 1970s, and it is widely used today. Using the 800MHz band has some disadvantages, though.

First, many organizations already have VHF or UHF systems with adequate coverage. To use trunking, they would have to scrap much of their current equipment and install a new 800MHz system and radio equipment.

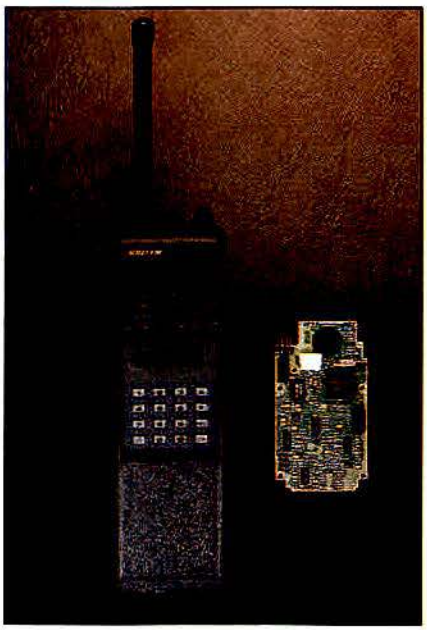
Second, 800MHz repeater systems cost more than comparable VHF and UHF systems. For extensive coverage, more repeaters are required to provide the same coverage area because 800MHz has less range. The cost of an 800MHz trunking system can be as much as triple that of VHF or UHF repeater systems.

Third, 800MHz mobiles and portables are more expensive than VHF and UHF units, especially units with mobile telephone interconnect capability.

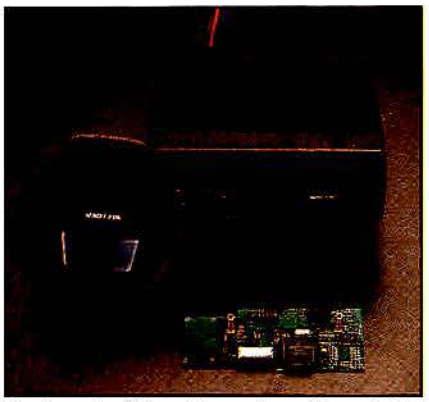
Scott is president of Comm-Tech International, Orlando, FL; and Soulliard is president of Midian Electronics, Tucson, AZ. The VersaTrunk versatile trunking system hardware described in this article was developed by Bendix/King and Midian Electronics for installation in radios manufactured by BK Radio, Lawrence, KS. Midian makes the computer-aided dispatch system described in the article. Certain software was written by Aviation Service, Vienna. The trunking hardware and software are marketed exclusively by Comm-Tech International.

New trunking protocol

Many radio users want increased spectrum efficiency and certain features that tend to come with 800MHz trunking equipment, but the FCC prohibits the use of 800MHz-type centralized interconnected base stations and switches in VHF and UHF systems. A new trunking protocol circumvents this limitation by placing the trunking functions into VHF and UHF mobile and portable units.



This portable transceiver trunks as many as 14 channels when fitted with the trunking circuit board.



Another circuit board coverts mobile units for versatile dispatch VHF and UHF trunking. Radiotelephone trunking is available, too.

Some previous attempts to install trunking circuitry in VHF and UHF units were limited to providing either dispatch or radiotelephone interconnect service. Other previous VHF and UHF trunking systems did offer dispatch *and* radiotelephone interconnects, but they sacrificed efficiency. For example, certain systems tie up two telephone lines and two radio channels to make one unit-to-unit dispatch call. This method is time-consuming, and it defeats the trunking objective of spectrum efficiency.

A versatile VHF and UHF trunking protocol, developed in 1994, incorporates the dispatch trunking capability using standard VHF or UHF repeaters—even with a customer's existing VHF and UHF repeaters. Dispatch requires no additional equipment at the repeater. Radiotelephone trunking only requires adding a simple terminal between each repeater and telephone line pair.

Module controls trunking

Trunking functions are accomplished in mobiles and portables fitted with a module that controls trunking, signaling,

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alphanumeric displays, dialing, multicity roaming and optional scrambling. The number of users per channel for VHF and UHF systems that are already at capacity can be increased with radios that automatically scan a pool of channels to find their own (individual or group) calls, as well as automatically finding an available channel to make outgoing calls. As many as 16 master groups and multiple subgroups can be defined.

Users can combine radiotelephone trunking, dispatch trunking and talk-around capability for any combination of as many as 14 channels. (Talk-around means direct unit-to-unit communications that bypass the repeater—a useful function when many users in the same organization are clustered in the same location for the same purpose.) As many as 10 city or zone groups (channel combinations) can be programmed for roaming. The name of each city or zone (channel group) can be displayed on the radio's alphanumeric liquid crystal display (LCD).

The screen displays system information and functions, such as an incoming automatic number identification (ANI), outgoing dialed numbers, as many as 10 missed calls, the 10 city-or-zone-channel group and as many as 10 individual names (in place of an ANI number).

Computer-aided dispatch

VHF and UHF radios can be used with a computer-aided dispatch (CAD) system that monitors all of the active channels and that tests to determine whether a valid preamble tone is present on any active channel. A preamble tone is transmitted by any unit as the first step in opening a communications link.

When a valid preamble tone is detected, the dispatcher's radio remains on the channel with the tone, and the system PC evaluates how to respond to the signal in one of the following ways:

- display the ANI number and a status message when received.
- display the communication between two system users.
- establishes communication between a field unit and the dispatcher.

If the preamble tone is not valid, the CAD system designates the channel as passive. Subsequent scans of the channel pool bypass the passive channel until no carrier is detected on that channel. Then, the channel once again is designated as active.

When the dispatcher places a call, the CAD system selects an empty channel and makes the call. If the call is not successful on that channel, the PC tries additional working channels until a valid response is received from the selectively called unit.

This method of system management gives a dispatcher station full system monitoring while retaining all of the desirable features of trunking.

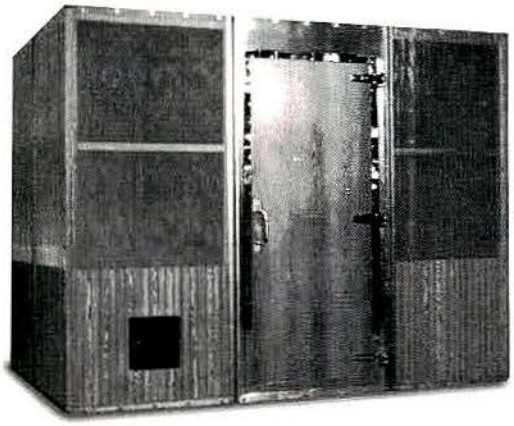
How it works

▶ *Dispatch calls* — The user dials the number of the unit or group to be called and presses the dispatch button. The radio trunks to an available channel and transmits a preamble tone followed by the called unit's ANI in any European 5/6 tone signaling format. If all of the channels are busy, the radio emits a "busy" tone, followed by an "alert" tone when a channel becomes available.

While waiting for incoming calls, each radio constantly scans all programmed channels at a rate of seven to 10 channels per second, looking for the proper preamble collect (group) tone. These tones

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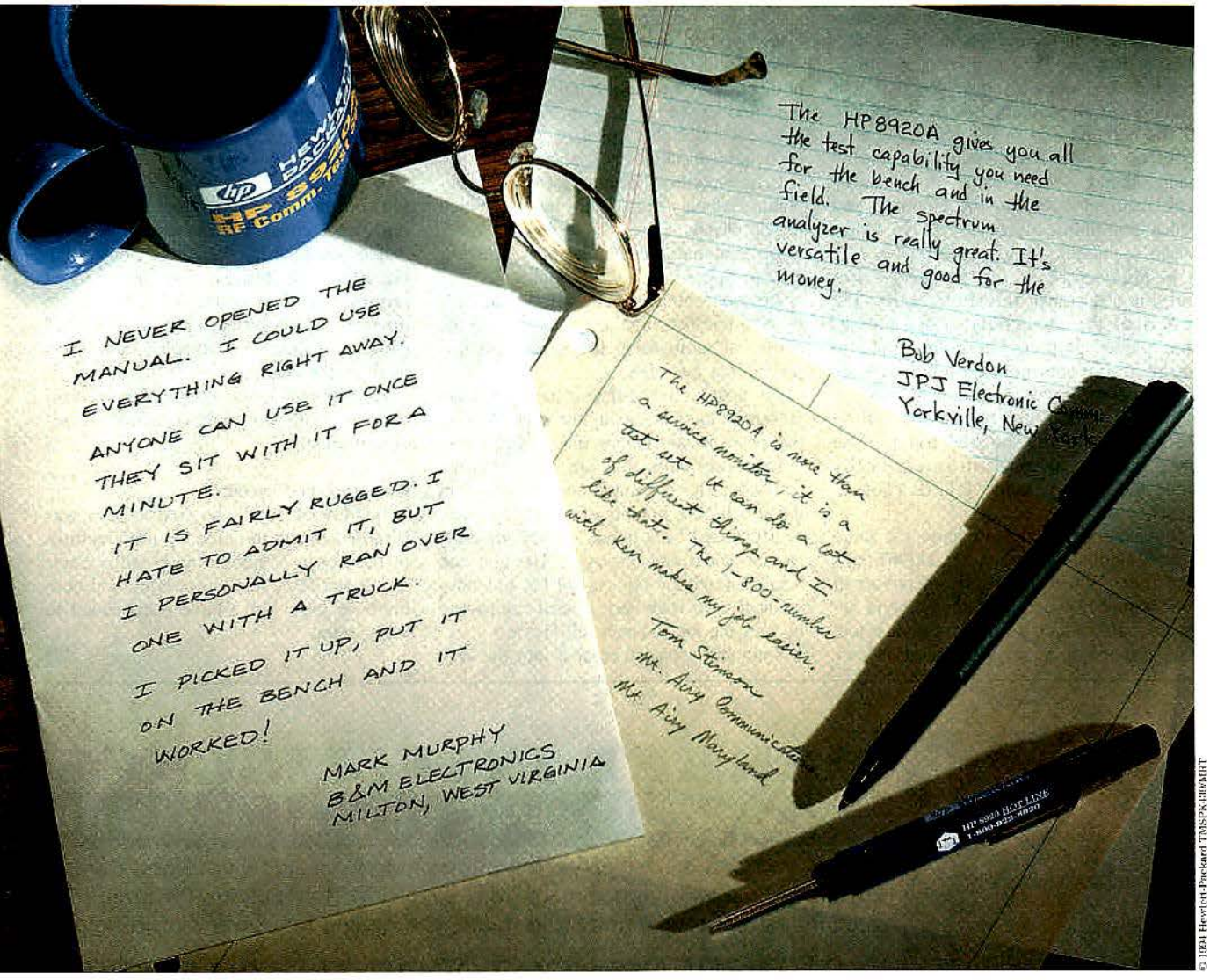
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last for about 125ms per trunked channel. For example, a four-channel system would require about 500ms to set up a call. When the proper preamble collect tone is detected, the receiver stops on that channel and decodes the selective call number for an individual or a group call. If the call number is for a single party, both units will handshake and display each other's ANI or name on the LCD. The receiver stays on the channel, and voice communication begins. No handshake is possible on group calls.

▶ *Radiotelephone interconnect* — For outgoing wireless telephone calls, the user dials the phone number and presses the "phone" button. The radio trunks to an available channel equipped with an interconnect terminal, sends its ANI to obtain dial tone and to provide billing information, emits the dial tone so the user can hear it, and then automatically dials the number using DTMF (Touch-tone) tones.

For incoming telephone calls, the radio scans the channel pool for a DTMF collect tone. When the proper selective call tone sequence is detected, the receiver activates, rings and the call is connected. The system can be designed to allow certain channels to be used for both dispatch and interconnect calls.

Other system details

VHF and UHF trunking systems can be initiated with a minimum number of channels and expanded to a maximum of 14 channels by adding standard repeaters for each new dispatch channel and repeaters with interconnect terminals for radiotelephone channels. Radios are reprogrammed to add channels.

An optional speech scrambler is available to discourage eavesdropping.

Recordkeeping includes all system calls by ANI number, time and date, or even the names of radio users if desired—all displayed and recorded.

As many as 100 different status calls can be sent to the base, using the portable keypad or a special trunking mobile smart mic.

Incoming calls that are not answered (missed calls) are automatically stored in the unit display, in order of receipt. As many as 10 missed calls (name or ANI number) can be stored and displayed. The user can scroll through the missed call list and automatically call back each missed call simply by pressing the dispatch call button.

Outgoing calls are entered into the keypad, and sent using either a "telephone" key for telephone calls; or a "dispatch" key for unit-to-unit calls. The number being called is also displayed on the radio's LCD to avoid mistakes. A 10-unit memory dial and last-number redial is included.

Lost or stolen radios may be "turned off" and later re-enabled from the base commander.

A programmable time-out timer is provided to prevent any single user from tying up the entire system, with a programmable penalty time to delay re-entry into the system (if desired). The interconnect terminal also provides a "radio usage timer" to limit system calls to a defined quantity of time, thus allowing more users to share the channel.

An "on-site" mode allows users to communicate with non-trunked radios on specific channels.

First installed system

In May of 1994, the first system was installed for nationwide communications in the Czech Republic by Aviation Service. Initial tests were successful, and hundreds of units since have been added to the system.

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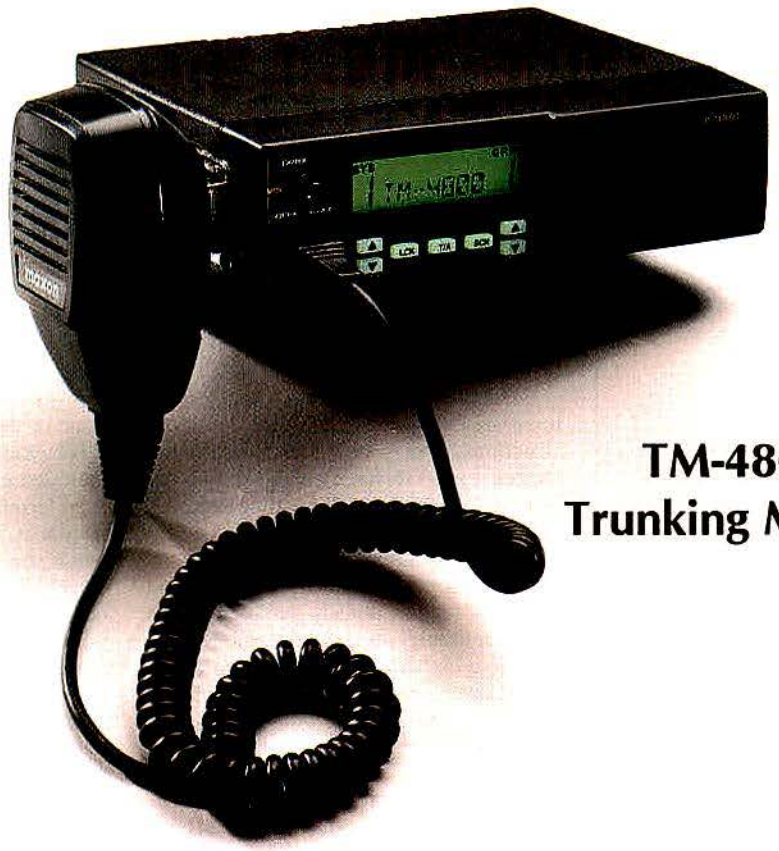
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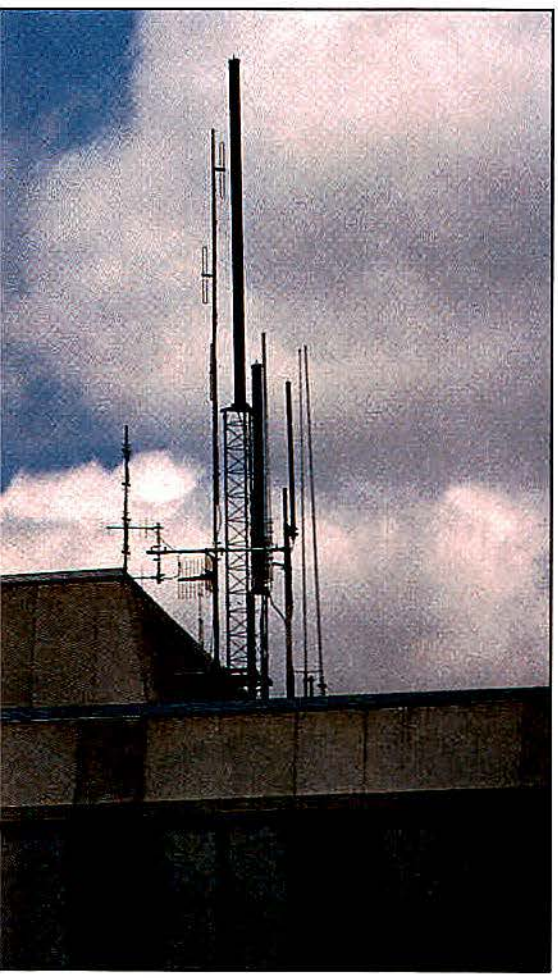
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How to select antenna sites for mobile communications

Selecting a remote site for mobile radio communications is an art and a science. You can use topographic maps, site inspections and radio noise measurements, but judgment and experience play a part, too.

By Roald Steen

Many factors should be considered when selecting a remote mobile radio communications site: site location vs. coverage area; site elevation; tower height, surrounding topography; leasing expense; accessibility; and security. A remote site may be used for one or more repeaters, satellite receivers, base stations or microwave communications relay stations.



The intensifying demand for antenna sites is boosting rental prices and crowding multiple antennas on rooftops where once only two or three antennas shared space. (Foxridge Towers Office Building, Overland Park, KS.)

▶ *Coverage area*—First consider the coverage area geography, including its size, shape and any obstructions it may contain that could affect radio communications.

For example, to cover a small downtown area subject to radio noise and obstructions, it may be better to use a site located a short distance outside the perimeter on a moderately tall building or tower, rather then a site inside the coverage area on the tallest building or tower.

One reason is that many repeaters and broadcast stations already may occupy the tallest building, raising the ambient RF noise to a high level that may affect reception. Lower, less crowded buildings and towers have fewer noise problems.

Another reason is that a tall antenna support structure is not necessary for covering a small downtown area. Much of the radio signal propagation in such an area relies on reflections, as signals bounce between building walls. Some knife-edge diffraction, and perhaps even some ducting along the streets, may contribute to the propagation of radio signals between two locations obscured from each other by buildings.

One more reason a high antenna may not be necessary to cover a small downtown area is that most of the mobile and portable radios that must communicate with the antenna site are at or near street level.

On the other hand, if the coverage area is large, such as a county, the highest possible tower location may be desirable.

▶ *Noise*—Take a spectrum analyzer to sites under consideration and measure the ambient radio noise. Another step that may help is to ask people who already use the sites for repeaters or other communications equipment.

Some radio sites with the most desirable locations and antenna heights may have the highest levels of radio noise, too. The reception problem often is circumvented by using separate receiver and transmitter sites. An example would be to place the repeater at the high but noisy site and add satellite receivers at quiet locations.

▶ *Coverage shape*—The geographic shape of the coverage area is important.

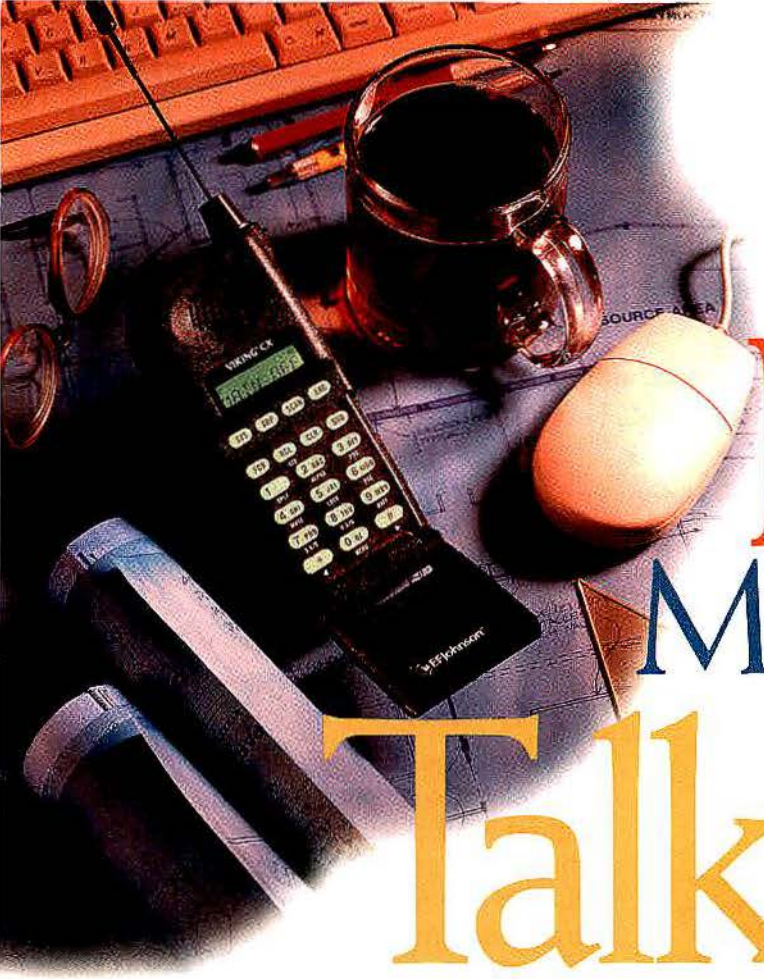
For example, a railroad may be chiefly interested in covering areas near its tracks. A preferred site may be one located near the tracks and equipped with an antenna with a sharp figure-eight emission pattern. Height may be less important than the right location near the tracks.

Some radio system users on inland waterways may have similar requirements. They may need good propagation in one or several river valleys. A location that is not particularly high, but that covers the river valleys fairly well, may be preferable to a high site obscured from part of the river valley by hills.

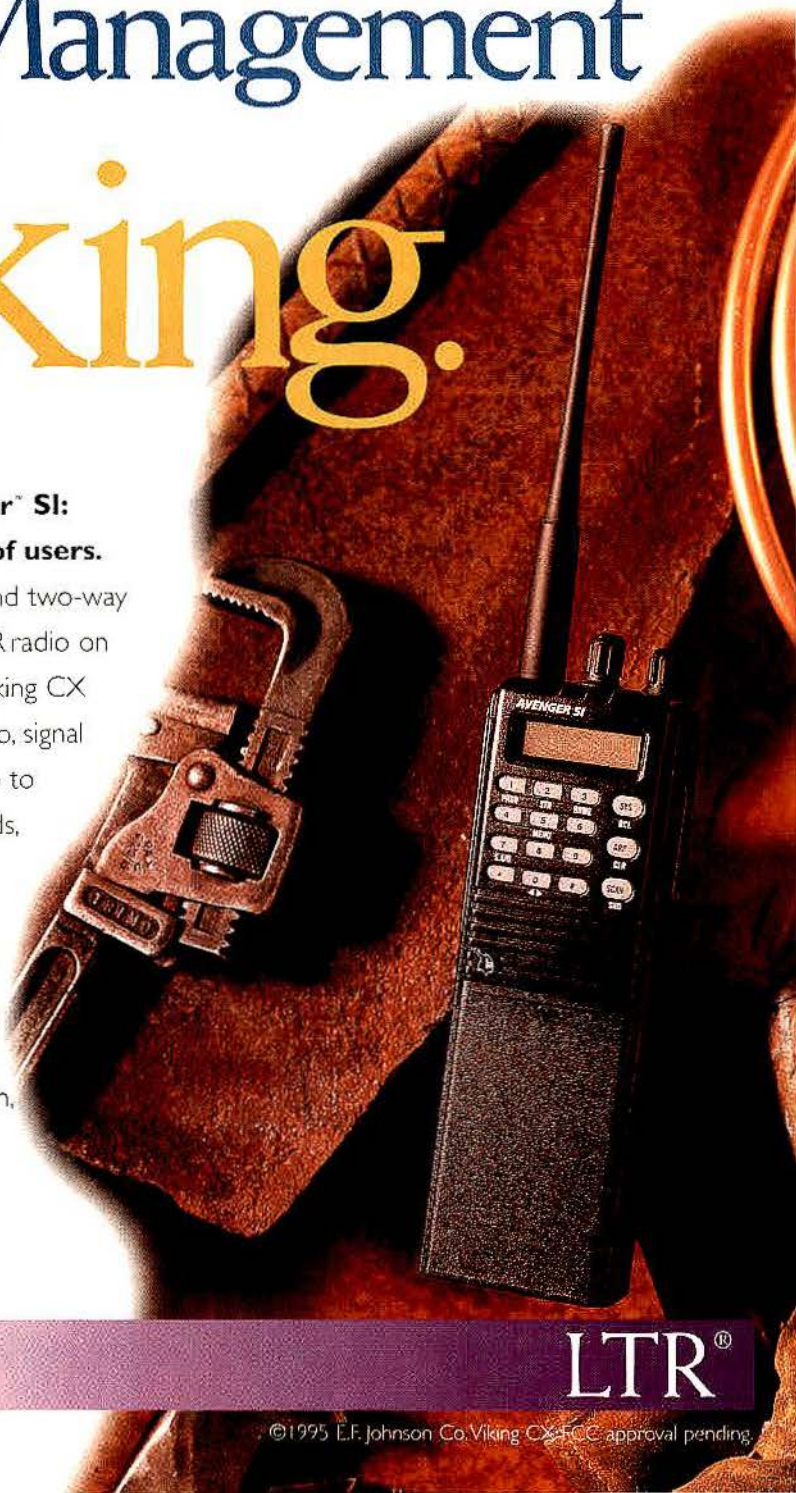
Maps are helpful in selecting and evaluating a site. The U.S. Geological Survey publishes well-made topographic maps, including 15-minute and 7.5-minute maps of almost all areas of the nation. These maps, which clearly show the topographic features which may affect propagation, can be purchased in map stores in most metropolitan areas. They also may be purchased or ordered from a bookstore.

Obviously, having a radio site near the center of the coverage area usually is the best solution. But there are times when a mobile radio service may decide that a location near the edge of the coverage

Steen is an electronics instructor and free-lance writer. He has worked as a two-way radio technician, and he lives in Woodbury, MN.



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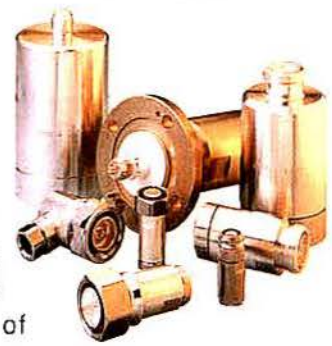
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area is better. By selecting antennas to shape the emission pattern to fit the coverage area, this type of location can be successful.

▶ *Visiting the site*—A site visit is indispensable when selecting a radio communications site. A visual inspection may uncover problems that are not apparent from the maps.

If possible, bring a spectrum analyzer to the site. If no utility power is available there, use a battery-operated analyzer.

Some of the most attractive radio sites are among the most crowded. Special problems may occur when many antennas are mounted near each other. Antennas for the same band that are mounted in the same plane tend to interfere with each other. The result may be that omnidirectional antennas exhibit unexpected directional characteristics. This situation is often encountered on the roof of tall buildings.

▶ *Accessibility*—Accessibility is important, both for sites atop tall buildings and for sites in open country. Some large buildings require permission from the building owner or the site manager for access to the part of the building housing the repeaters and microwave equipment. Some of these buildings may not be easily accessible outside of regular business hours.

For remote sites, road access must be evaluated. A site near a highway should be perenially accessible, but radio sites often are located at more remote locations.

Some remote sites may require helicopter transportation for easy access. Although helicopter transportation is expensive, it may be worth the price for a mountaintop site that covers a wide area. When such a site is used, it is especially important to include redundant equipment to avoid the need for frequent repair or maintenance visits by technicians.

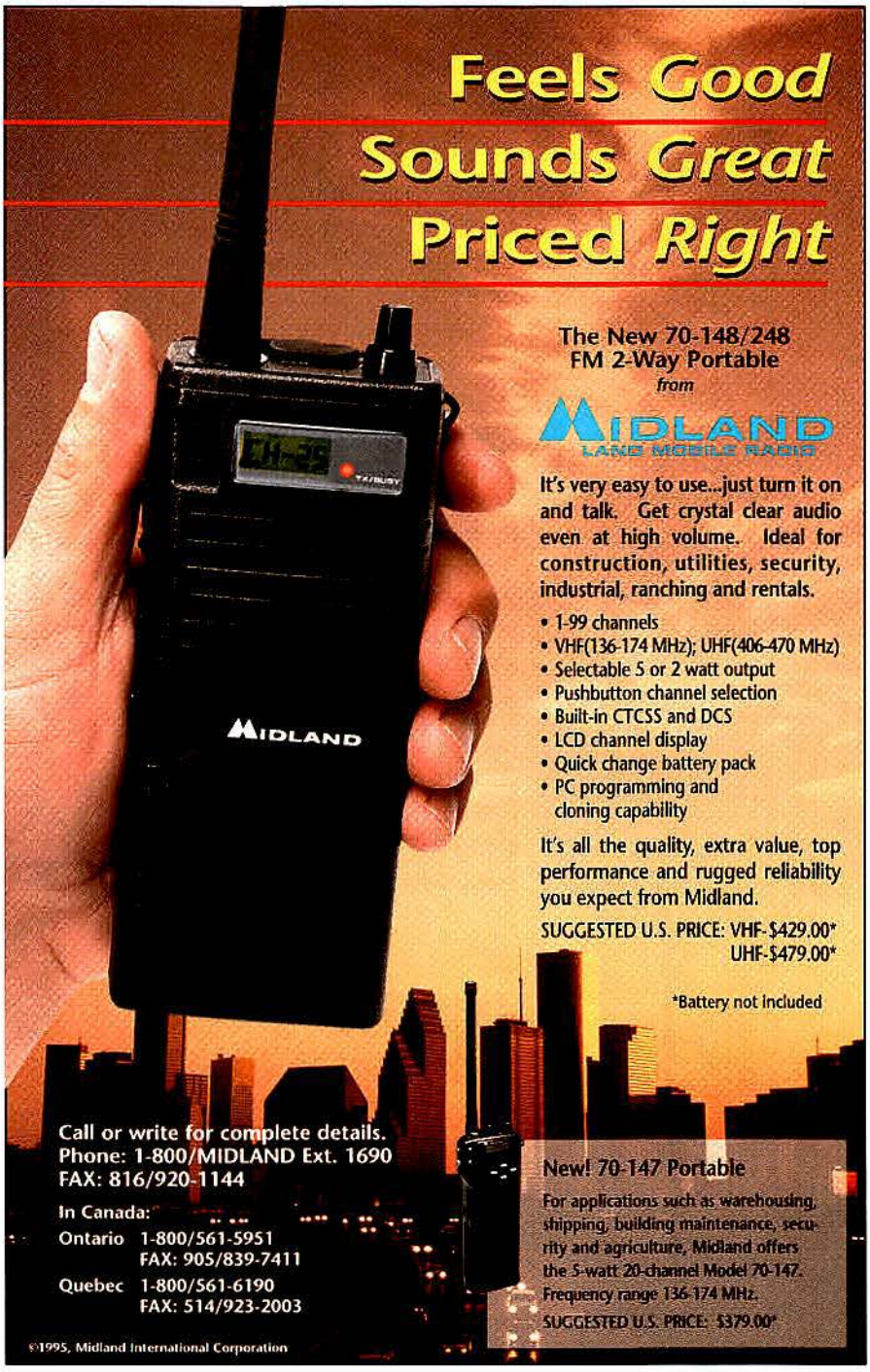
Flooding may cause problems for sites that must be reached via dirt roads.

Some remote sites are reached via seldom-used dirt roads. A dirt road may not be among the first to be cleared following a snow storm. The limited road maintenance may make access most difficult when the site is most likely to need service.

Flooding may cause problems for sites that must be reached via dirt roads. At times, these roads may be too muddy or submerged to travel.

A private road between the public road and the site may need to be cleared of snow during the winter. Many owners or managers contract with people living near their sites to remove snow. It is also common to contract with someone living near the tower to observe its lights for proper functioning and outages. During the summer, it may be desirable to have someone cut the grass and otherwise make sure the landscaping is well maintained.

▶ *Security*—Site security is important. Some radio installations in large buildings have such a well-developed security system that technicians may have difficulty entering. If a repeater is to be located in a building, it should be put in a special room for the purpose. Keys should be available only to radio service technicians and to



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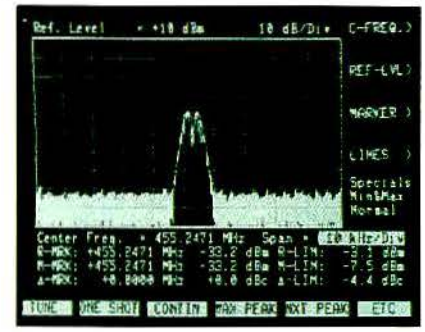
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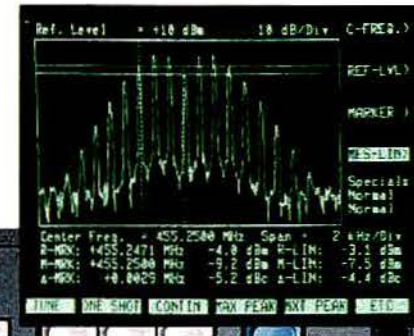
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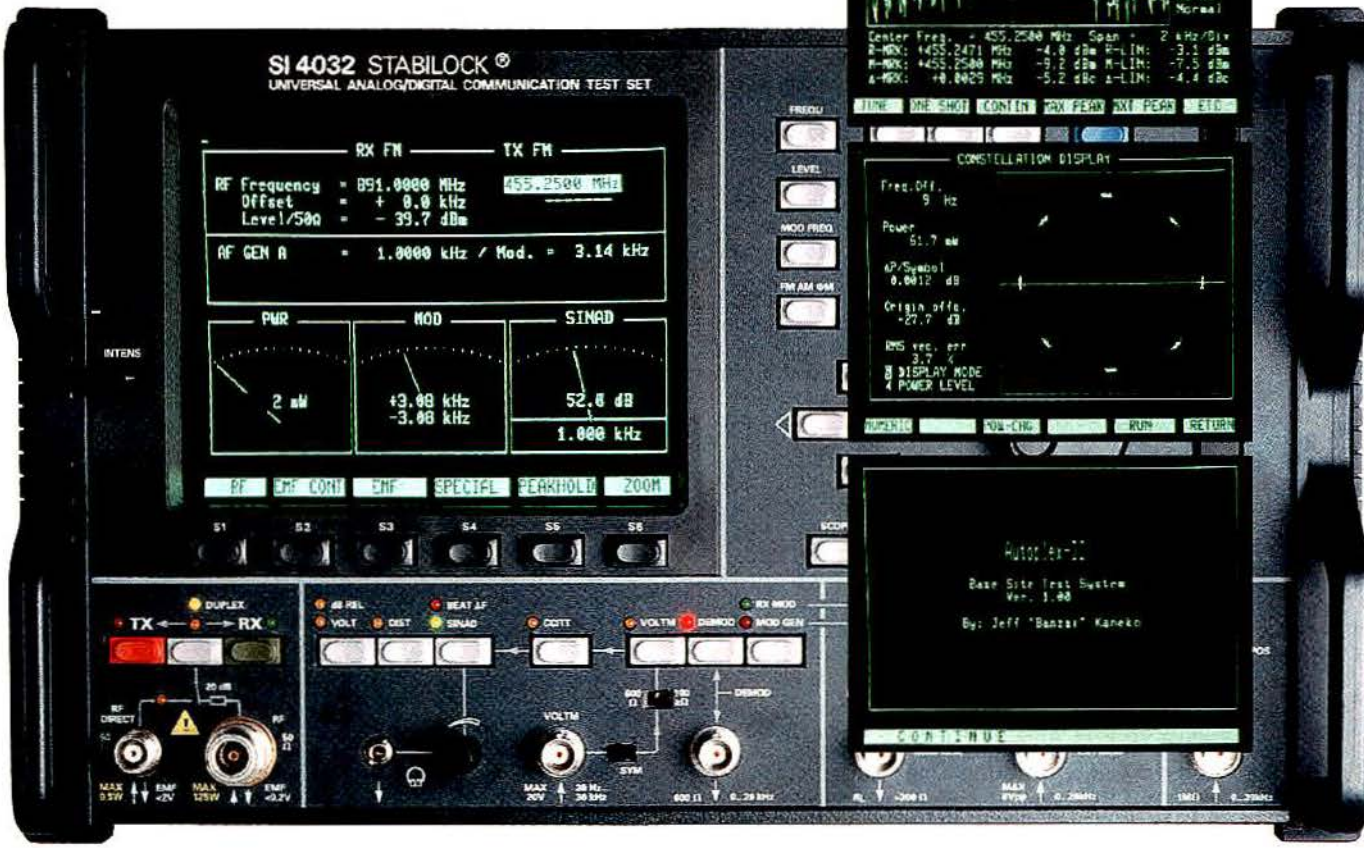
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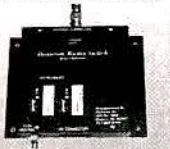
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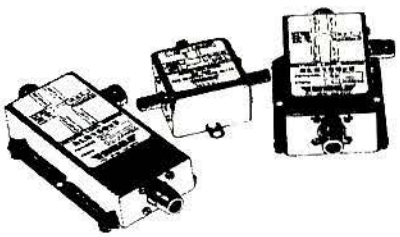
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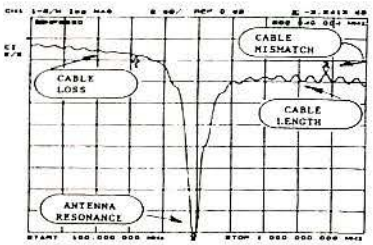
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For remote sites, there is a certain compromise between accessibility and security. A site with a good access road may be more likely to be vandalized than a site that is not so easy to reach.

Protection from vandalism and theft may include fencing and telemetry circuits. Through the telemetry system, the radio service shop or a dispatcher is informed whenever someone enters the site. Police can be dispatched quickly if an unlawful entry should occur.

▶ *Shelter evaluation*—The building or room that will house the equipment should be evaluated. It should be weatherproof. It should have room to work and room for expansion.

▶ *Leasing*—Lease terms and price are important considerations when a site is to be evaluated. However, lease or purchase terms and negotiations are beyond the scope of this article.

▶ *Power*—The site needs electric power. Although some sites (such as mountaintops) are so good that lack of electric utility power is not considered an obstacle, in general, it is better if utility power is available. Photovoltaics (solar panels) and wind-driven generators are alternatives at sites without electric utility power.

Important communications sites should have backup power. Some use only batteries, which can do the job during limited electric outages, provided that the important equipment at the site can operate with dc voltages. Other sites have fuel-powered generators that start automatically when utility power fails.

Telephone service availability at the site may influence the choice. Telephone lines may be needed during service work at the site or to connect the site with control and dispatch locations. Telemetry also may require telephone lines.

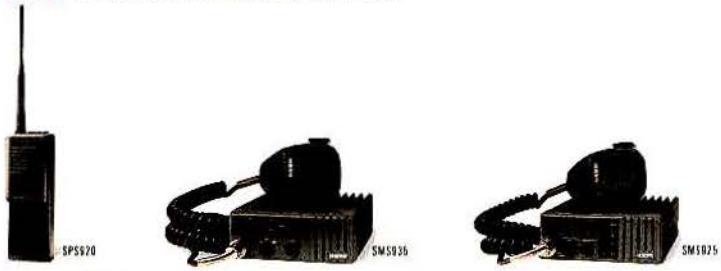
As an alternative to telephone lines, site communications can use microwave circuits. The same microwave circuit connecting the repeater site to the dispatch console, satellite receivers or control points may be used for telemetry and on-site communications during service and installation work. Additionally, technicians may communicate via the microphone at a repeater cabinet or via portable radios.

Selecting a remote site for mobile radio communications is a combination of an art and a science. Much information can be gathered from topographic maps, site inspections and radio noise measurements. The individuals responsible for selecting the site use their judgment and experience, too.

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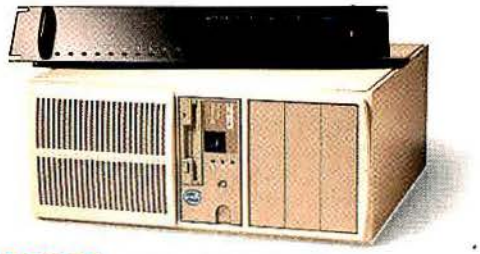


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Servicing pagers: The information highway

Part 16—Some tips for programming Bravo Plus and Bravo Express pagers help you to bypass possibly unnecessary bells and whistles. It may be better to have the pager 'beep on bad data' than to risk undelivered messages.

By David Ludvigson

The interface between the pager and its programming device is relatively simple. Serial information is read sequentially from the pager into the program or, conversely, from the program into the pager. Although the presentation of this data "looks" different than the Bravo programmer presentation, actual differences between the IBM-compatible computer hookup and the Bravo programmer are minor, as far as data handling is concerned.

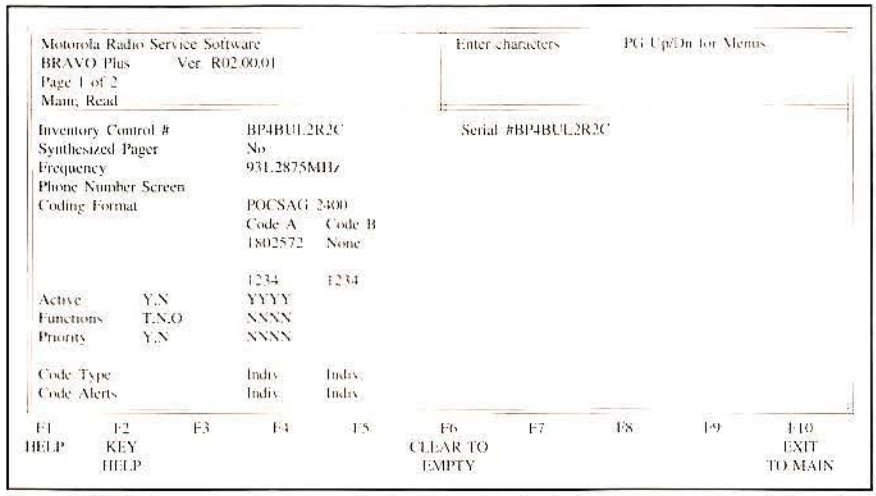


Figure 1.The first programming screen for the Bravo Plus includes some superfluous information that has little to do with the operation of the pagers.

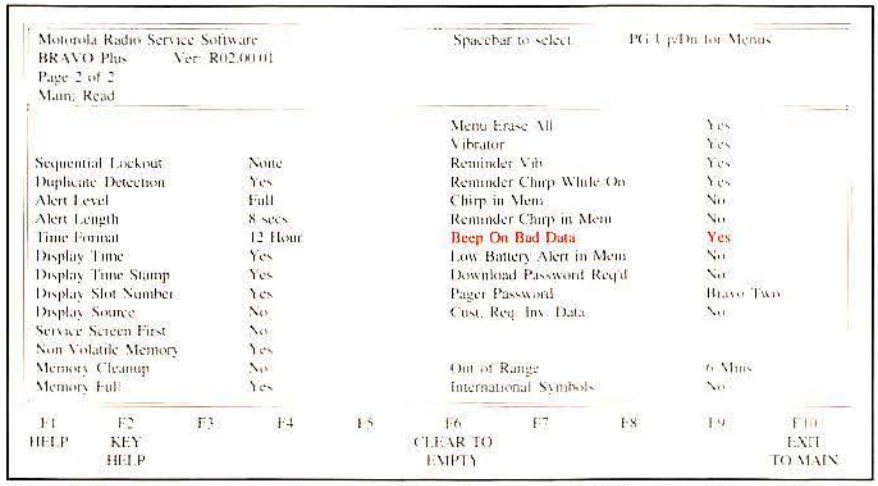


Figure 2. The second programming screen offers a 'beep on bad data' option. More on this in the text. Additional clock options are not vital.

I mentioned that much of the information filled in at the computer is just so much junk as far as the paging operation is concerned. With a crystal-controlled pager, there is no point in identifying operating frequency—it is nice to have but not necessary. Clock options are other "nice to have" features, but they are not terribly vital—but I have made my point.

As described in "Servicing Pagers: Microprocessor Board" in the November 1994 issue, there is a definite pattern to the Bravo programmer. First, you define whether to program POCSAG or Golay information; then you look for NORMAL or INVERTED data handling, and so forth.

With the Bravo Plus and Bravo Express, this "fill in the blanks" form of programming gets muddled. Suddenly, there is room for serial numbers, passwords, meaningless frequency information, clock options and cadenced tone alerts—none of which has anything to do with the operation of the pager! Bells and whistles!

As you fill in the various pieces of information, a "string" of information is created for downloading into the pager's codeplug. Pieces of this "string" will be placed into specific program locations where they will be used to perform individual tasks.

Once programmed, the pager operation resolves itself to performing specific tasks at certain well-defined times. When initially turned on, the whole system performs a reset, clearing the memory, performing self-testing functions and resetting the clock display. Capcode information is downloaded from the codeplug into

Ludvigson is a technician in Houston.



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the proper memory location, the receiver "on-time" cadence is determined by the POCSAG data rate information, and the audio filter is activated to pass the data stream information at the selected speed.

The receiver is enabled for a specific period during each BATCH transmission. This is a function of the CAPCODE. If, during the BATCH, the CAPCODE is matched, the information contained in the following 32 bits transfers to the microprocessor. Decoded, these bits form the numerals that are passed to the display.

When the data matches the CAPCODE, several operations occur. First, the cadenced tone generator sounds (while the phone number is being decoded). Clock information is stored to indicate the hour at which the page arrived at the pager. In this manner, two memory locations are occupied and sequentially accessed via the gray (READ) push-button.

If the user wishes to LOCK the information in the pager, a form of "scratch-pad" memory stores the number and time in the next available scratch-pad slot. The LOCK key serves to latch or to unlatch this data, and a padlock symbol appears in the display to indicate saved data. Unlike the Bravo, the Bravo Plus and Bravo Express do not necessarily drop memory contents when the power is turned off. Instead, they offer a CLEAR function to erase those numbers that are UNLOCKED.

The majority of functions found in the Plus and Express are virtually identical to those of the Bravo. (See "Servicing Pagers: "The Receivers," May 1994 issue.) The receiver boards differ in that the

Pager servicing series

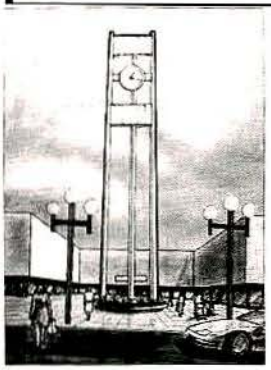
Part 1: "Build a Shielded Room," January 1994. (All pagers.)
Part 2: "Build an 'IFFER,'" February 1994. (Bravo, Bravo Plus, Bravo Express.)
Part 3: "Frequencies, Coding Formats," March 1994. (Bravo.)
Part 4: "From Bench to Programmer," April 1994. (Bravo.)
Part 5: "The Receivers," May 1994. (Bravo.)
Part 6: "Elegant Simplicity," June 1994. (Bravo.)
Part 7: "Problems in Paradise," July 1994. (Bravo.)
Part 8: "406MHz–512MHz Receivers," August 1994. (Bravo.)
Part 9: "150MHz Receivers," September 1994. (Bravo.)
Part 10: "Tales Crystal Filters Tell ...," October 1994. (Bravo, Bravo Plus, Bravo Express.)
Part 11: "Microprocessor Board," November 1994. (Bravo.)
Part 12: "Headaches (and Some Aspirin)," January 1995. (Bravo.)
Part 13: "Mixed Signals," February 1995. (Bravo.)
Part 14: "Essential Differences," April 1995. (Bravo Plus, Bravo Express.)
Part 15: "And You Shall Receiver Knowledge ...," June 1995. (Bravo Plus, Bravo Express.)
Part 16: "The Information Highway," July 1995. (Bravo Plus, Bravo Express.)

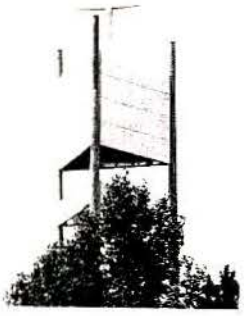
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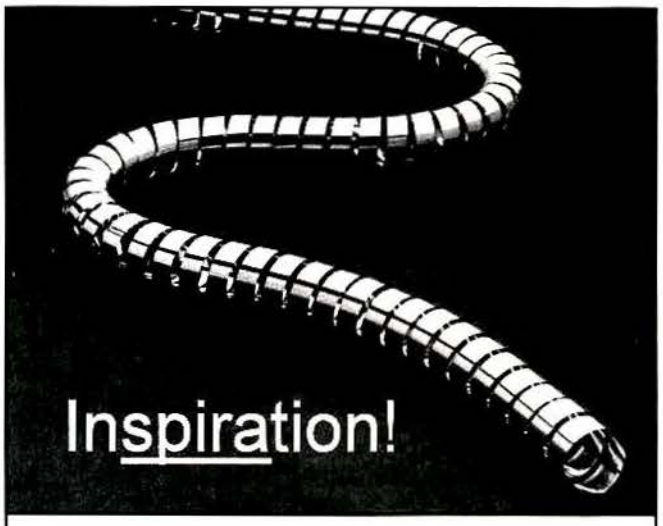


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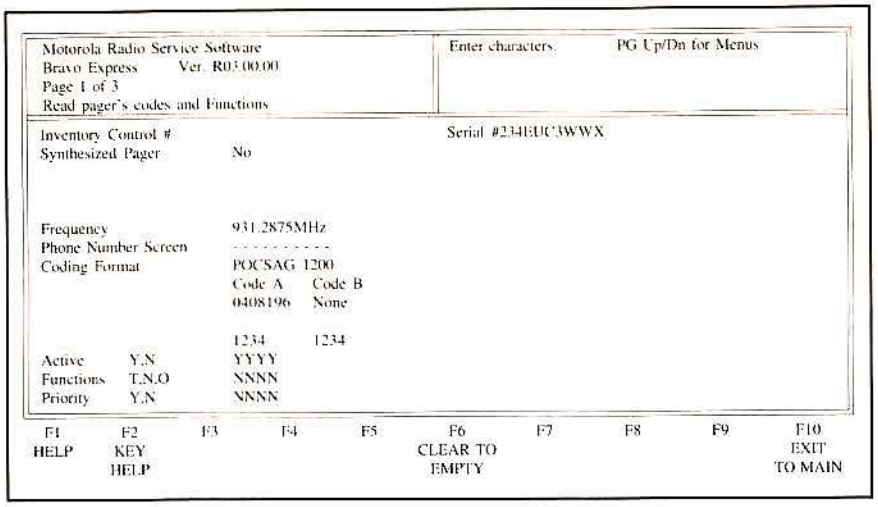


Figure 3. The first programming screen for the Bravo Express specifies the operating frequency—nice, but not necessary for a crystal-controlled pager.

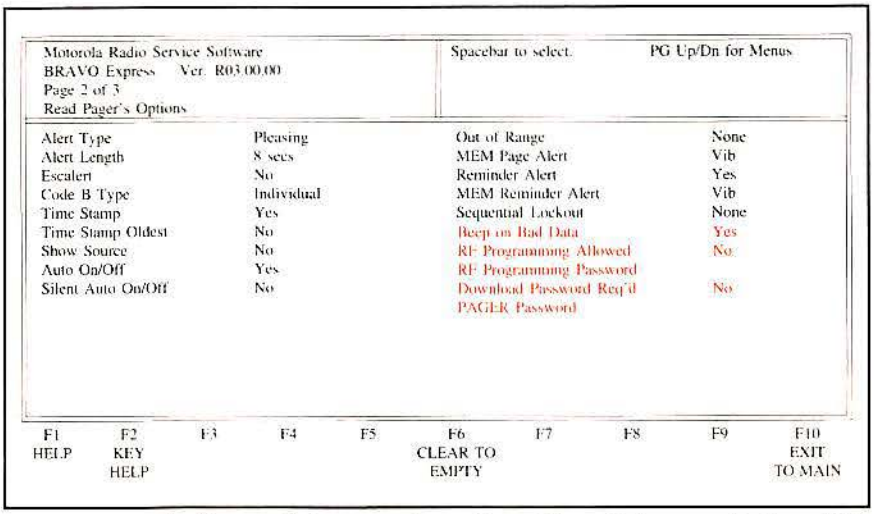


Figure 4. 'Beep on bad data: yes' helps to reveal reception problems. 'RF programming' is available on the Bravo Express; see text about 'RF downloading.'

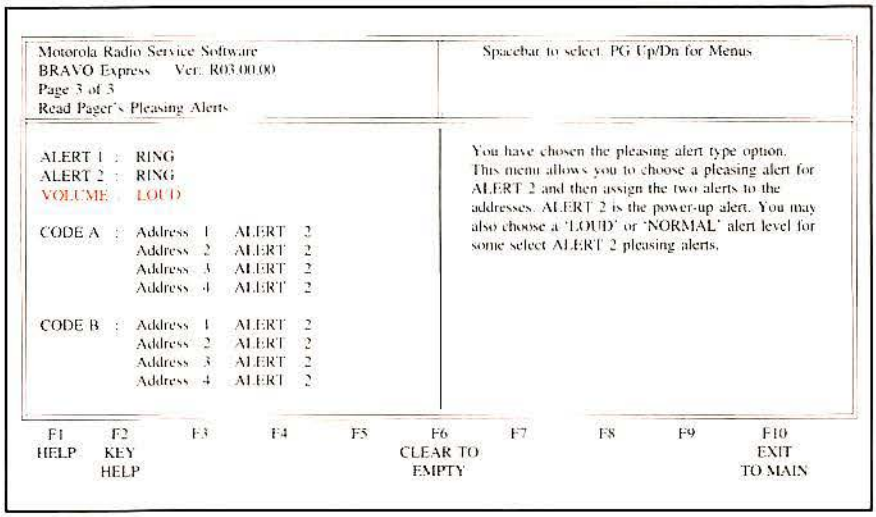


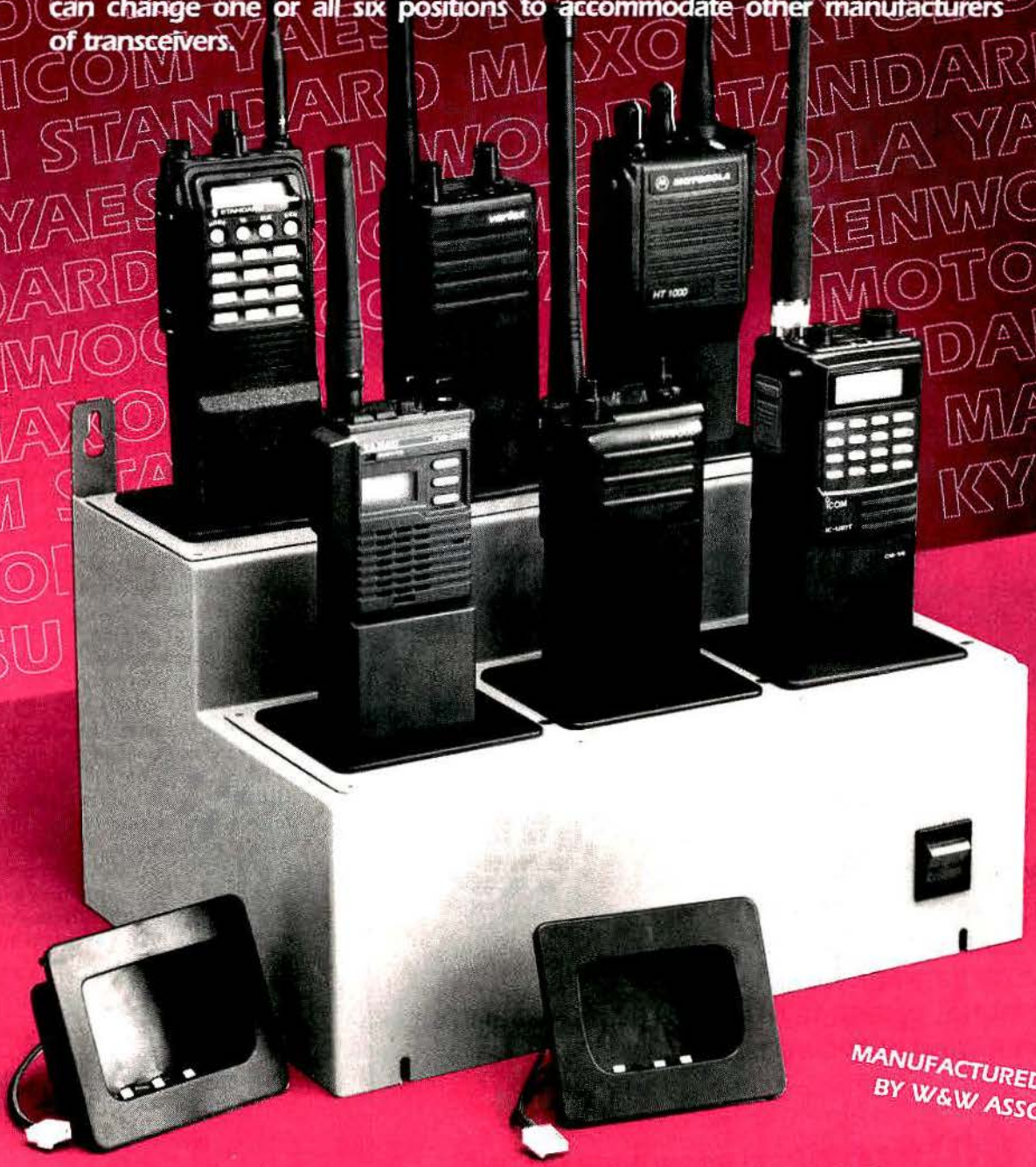
Figure 5. The third programming screen for the Bravo Express allows a selection of loud or normal alert levels.

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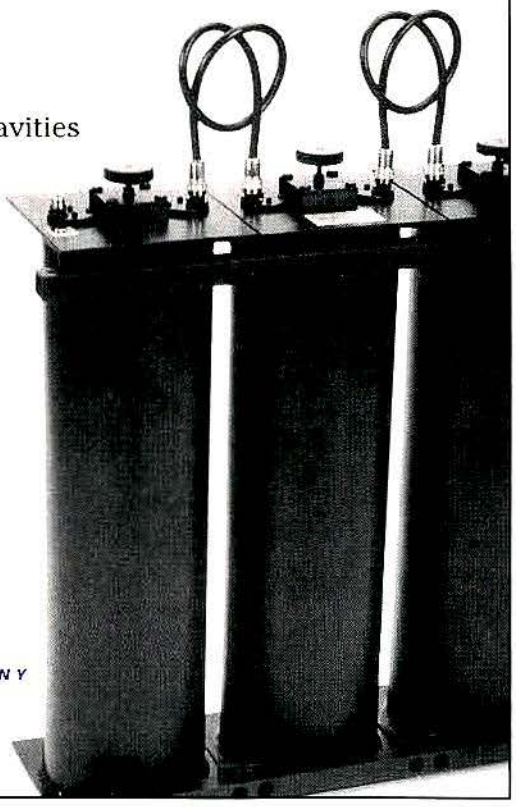
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Bravo uses an external resistor-capacitor (RC) data filter, whereas the Plus and Express use a two-port, selectable-bandpass active filter within the detector integrated circuit (IC). Attempts to use the Bravo and Plus/Express receiver boards interchangeably will result in frustration. They are not compatible.

Express programming features

The Express program has several options that may be confusing to the first-time user. "RF downloading" is a feature that has found favor in the alphanumeric pager business because it allows the same transmitter that has been transmitting stock price information from Dow Jones to turn off any selected customer's capcode by sending the proper preamble and text. It controls service delivered to a late-paying user. Similarly, the RF-downloading feature may be used to select any of a number of datastreams (e.g., paging, stock prices or sports scores) to be decoded at the pager.

Current technology could easily provide paging companies with such ability. Such service is not supported in the Express, though, so any selections made in the "RF downloading" option are ignored by the pager. It is just as easy for the paging company to enable or disable an individual capcode at the switchboard.

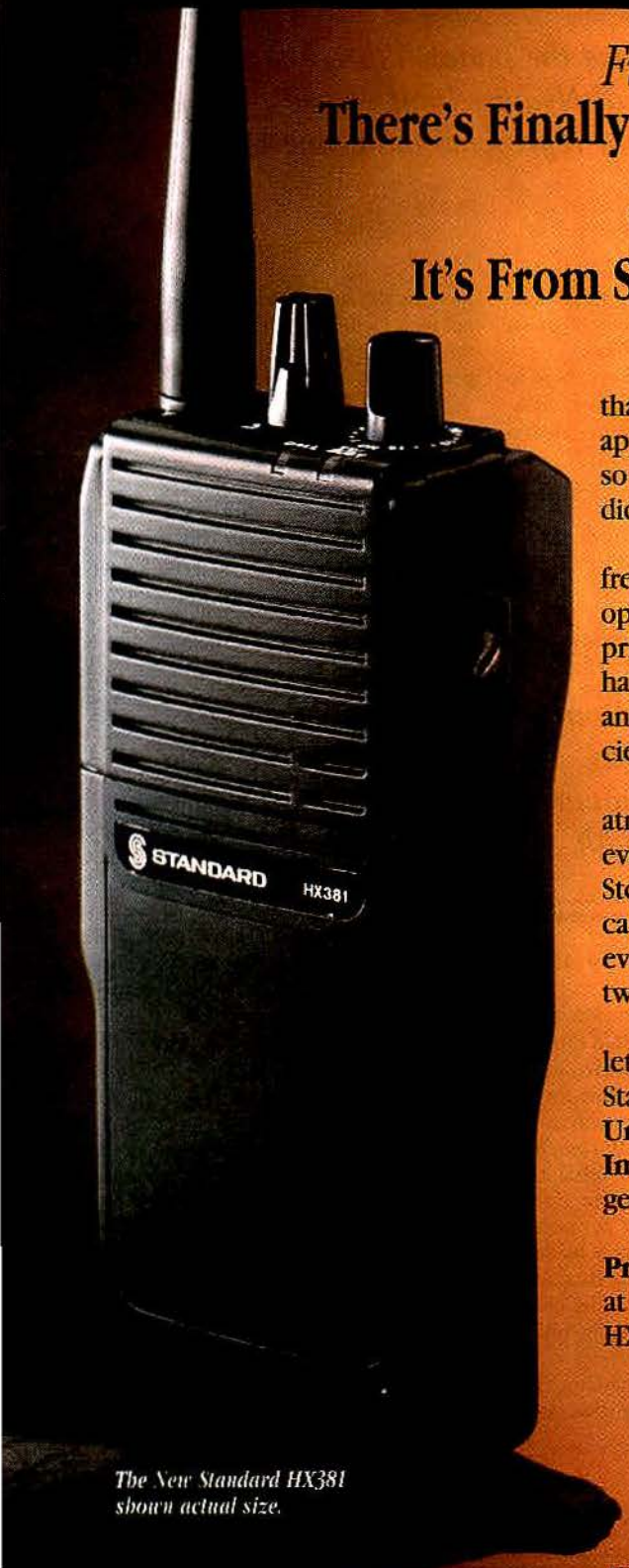
Another feature of the program is the "beep on bad data." In areas where simulcast signals overlap, the possibility of phasing differences causing an imperfect match of the capcode exists. When the signal strength is relatively weak, the Bravo family of pagers often is willing to decode "bad" data. Received pages are solid when signal strength and phasing are favorable, but the letter "E" creeps into messages under unfavorable conditions—also when the receiver is out of alignment.

If the "beep on bad data" is left off (BBD=N on the Bravo), count on customers complaining of missed pages. I would rather have customers tell me they are getting "E's" in their messages than to have them miss them entirely. A few minutes on the alignment bench might be all that is required to restore proper operation.

Acknowledgement

I would like to thank the management and staff of JJ Sounds and Communications, South Houston, TX, for their help with this project. Tel.: 713-944-1813.

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Getting more out of a paging channel

Four-level modulation can be used to increase the bandwidth efficiency of a paging channel. To overcome the theoretical Nyquist limit of two bits per hertz, data are encoded so each symbol represents more one bit.

By Don Siperko

Let's face it, the whole purpose of being in business is to make money and to grow the business accordingly. In any business, the most obvious way to reach these objectives is to sell to more customers. In the highly competitive paging industry, customer growth is critical. The customer base can be expanded with competitive rates, special service offerings or both.

Although this method is simple, the reality is that the system operator has a finite resource (radio spectrum) to use in serving an increasing number of subscribers. As the amount of paging calls that can be sent on the available spectrum nears its limit, new decisions must be made to sustain growth.

The phenomenal increase in demand for traditional paging and messaging services requires an increasingly efficient use of radio spectrum. In fact, in many major markets, spectrum for traditional one-way paging has been "maxed" out. Further evidence of the need to enhance spectrum efficiency was the FCC's auction of two-way paging frequencies in which bids—exceeding everyone's expectations—topped $1.2 billion.

Alternatives

The paging industry boom is sure to make many companies prosper; nevertheless, as channel use nears capacity, service providers will be forced to seek alternatives to facilitate growth. Service providers undoubtedly will consider procuring new channels, using other carriers' systems, making more efficient use of existing channel(s) or a combination.

The most cost-effective approach is to maximize the capacity of existing channels. Four-level modulation allows such a capacity increase.

Transmission efficiency

The objective is to pack as much data as possible into a channel of finite bandwidth. To analyze the problem, we use a fundamental theorem presented by Harry Nyquist (1889–1976).

The objective is to pack as much data as possible into a channel of finite bandwidth.

From Nyquist theory, a data rate of $2B$ bits per second can be transmitted through a channel with a bandwidth of BHz. Stated in terms of a normalized value, this theory means that data can be transmitted at the rate of 2 bits per hertz. In this case, the data rate is the same as the symbol rate (i.e., each symbol represents one bit of data). Assuming a bandwidth restriction of BHz, then the only way to achieve a higher data rate is to encode the data such that each symbol transmitted on the channel represents more than a single bit of information.

With multilevel (M-level) encoding, the effective data rate can be expressed as:

$$R = 2B\log_2(M) \quad [1]$$

The effect of multilevel encoding is to increase the spectral efficiency of the channel by a factor of M. Equation 2 represents this result by normalizing the throughput per hertz of bandwidth.

$$R/B = 2\log_2(M) \text{ bits/Hz} \quad [2]$$

As an example, assume that a system is currently using Flex 1600 two-level transmission. From Equation 1, the data rate is $2B$ where B equals 800Hz. With M equal to 2, the normalized data rate is again 2 bits per hertz.

Suppose we want to transmit 3,200 bits per second in a bandwidth of 800Hz. If we tried to transmit one bit per symbol, at least 1,600Hz of bandwidth would be required to comply with Nyquist theory. On the other hand, if we use four-level modulation in an 800Hz bandwidth, the data rate from Equation 1 would be 3,200 bits per second. From Equation 2, we see that we are now transmitting four bits of data for each hertz of bandwidth. What we have achieved is an increase in spectral efficiency by a factor of four as compared to two-level modulation, which yielded a gain of only two.

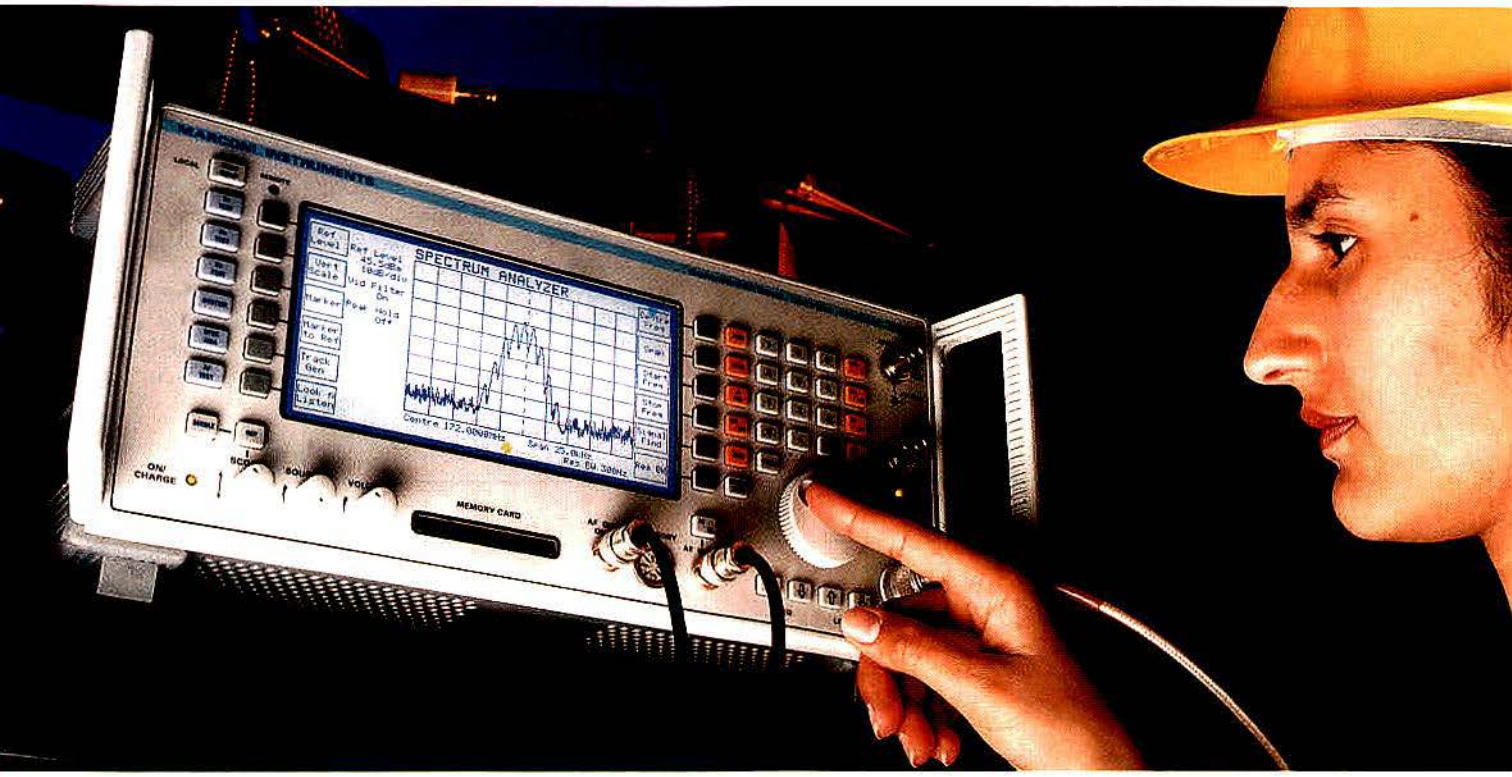
This theory is what makes Flex a much more spectrally efficient protocol than POCSAG. POCSAG is a two-level protocol only, whereas Flex may operate in either a two- or four-level fashion, depending upon the desired Flex speed.

Realizing spectral efficiency

The predominant modulation scheme used for paging is frequency modulation (FM), or more precisely, binary frequency-shift keying (FSK). With this technique, a binary bit of information is represented by a particular frequency in a set of signaling frequencies. The information is conveyed by using a frequency in the set to cause a change in the instantaneous frequency of the carrier around its assigned center frequency. We can easily determine the number

Siperko is is a staff engineer with Motorola's Global Paging Infrastructure division engineering group in Ft. Worth, TX. His principle duties include research, testing and design of flexible wide-area synchronous protocol (Motorola Flex) infrastructures.

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of frequencies required in the signaling set from Equation 3.

$$M = 2^B \quad [3]$$

In Equation 3, M is the number of elements required in the set, given the objective of transmitting B bits of data per element. As an example, with 1,200-baud POCSAG, B equals 1; therefore, two elements are required in the signaling set. The elements are commonly known as the binary deviation and are typically ±4.5kHz. If a binary 1 is represented by +4,500Hz, and a binary 0 is represented by –4,500Hz, the instantaneous frequency appearing on the channel will be $f_c \pm \Delta_f$ where f_c is the assigned center frequency, and Δ_f is the frequency of the signaling element.

One additional item worthy of mention is how the data rate affects deviation. If we assume a data pattern of alternating 1s and 0s and the 1,200-baud POCSAG protocol, then the rate of change of deviation transitions between $f_c + \Delta f$ and $f_c - \Delta f$ will occur at a rate of 1,200 times per second.

To implement a bandwidth-efficient protocol such as Flex, four signaling elements (frequencies) are required, with each frequency representing 2 bits of data. The Flex set of signaling elements has been well-defined and includes the frequencies +4,800Hz, +1,600Hz, –1,600Hz and 4,800Hz.

Deviation amount

In two-level signaling such as POCSAG, there are only two possible deviations around the assigned center frequency, typically ±4,500Hz. The data entering the encoder determine which deviation to select. In a typical encoder, the data coming into the encoder are used to control a reference voltage supplied to the modulator. Depending on the reference voltage, the deviation swings either positive or negative. Because there are only two elements in the signaling set described above, only two distinct voltage levels are required.

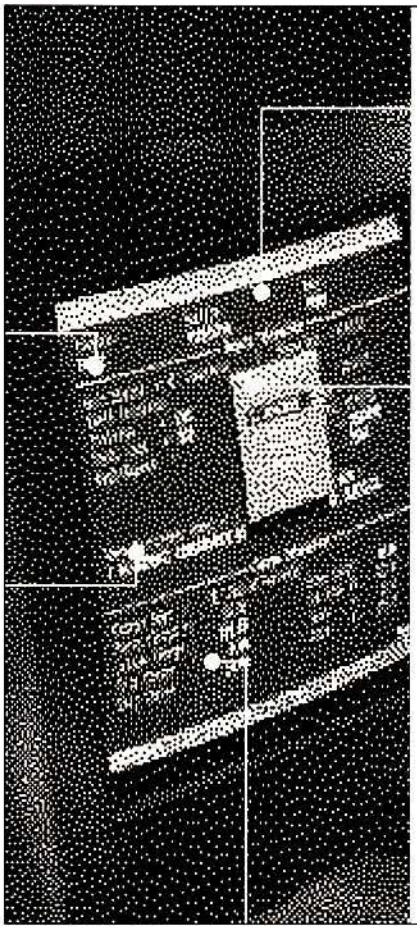
As the number of elements in the signaling set increases, the number of voltage levels used to drive the modulator must also increase. In Flex, four voltage levels are required to select the four possible deviations listed above. Which voltage level (or deviation) to select depends directly on the data received by the encoder. For example, if the two-bit sequence received is 1,0, the encoder will output a control voltage to select +4,800Hz; if the bit sequence is 0,1, the encoder will output a different control voltage to select –1,600Hz. A complete listing of the deviation selected given a two-bit sequence is as follows:

FLEX FOUR-LEVEL FM

BIT SEQUENCE	DEVIATION IN HERTZ
10	+4,800
11	+1,600
01	–1,600
00	–4,800

Summary

A four-level modulation scheme such as Flex can provide significant increases in bandwidth use, as shown from both theoretical and practical implementation perspectives. Considering that the radio frequency spectrum is a finite resource and that procuring new spectrum can be costly, system operators should explore the use of Flex to increase system capacity and to grow their business.



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Local control for base stations, repeaters

Modifications for two of the most common types of base stations and repeaters facilitate local control for units that are designed for remote control. Motorola and Ericsson equipment is covered.

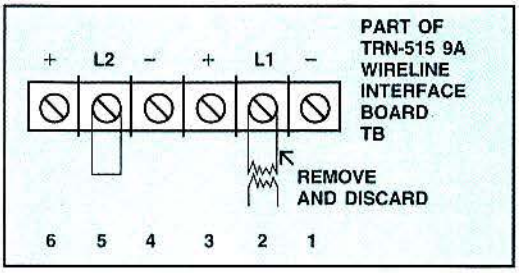


Figure 1. Follow the steps described in the text to modify the Motorola MSF 5000 base station for local control.

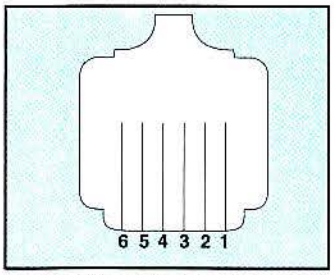


Figure 2. Front view of J812 located on front of MSF-5000 control shelf.

Table 1. Pinout provided by modification.

PIN	FUNCTION
1	PCB
2	SPKR AUDIO
3	MIC PTT
4	MIC AUDIO
5	AUDIO GND
6	LOGIC GND

Table 1—The Motorola MSF 5000 modification brings PTT, Tx and Rx audio out to the side of the cabinet, as shown by this pinout information.

By E. Kirk Ellis

Carolina Power & Light's (CP&L) radio network covers about half of North Carolina and a third of South Carolina with voice, alarm and load-control transmitters. Innovative ways to operate the system that cut costs and reduce equipment requirements are always welcome.

Two recent projects required local control of base stations and repeaters. The older radio equipment generally provided an easy way to connect with outboard equipment, but many of the newer stations do not include an easy way to connect with push-to-talk (PTT) control or audio input. Simple modifications implement these functions in Motorola MSF 5000 stations and Ericsson Mastr IIe/Mastr III stations.

MSF 5000 stations

A simple way to achieve local control of the Motorola MSF 5000 base station without purchasing the special option is to use the terminal block on the wireline interface (WLI) board. This board is the external terminal block provided as standard equipment. It is on the right-hand side of the cabinet near the line cord. This terminal block provides easy interconnection outside the cabinet to outboard equipment. An added bonus is that it includes surge protection.

Ellis is director of project integration at Lawrence Behr Associates, Greenville, NC.

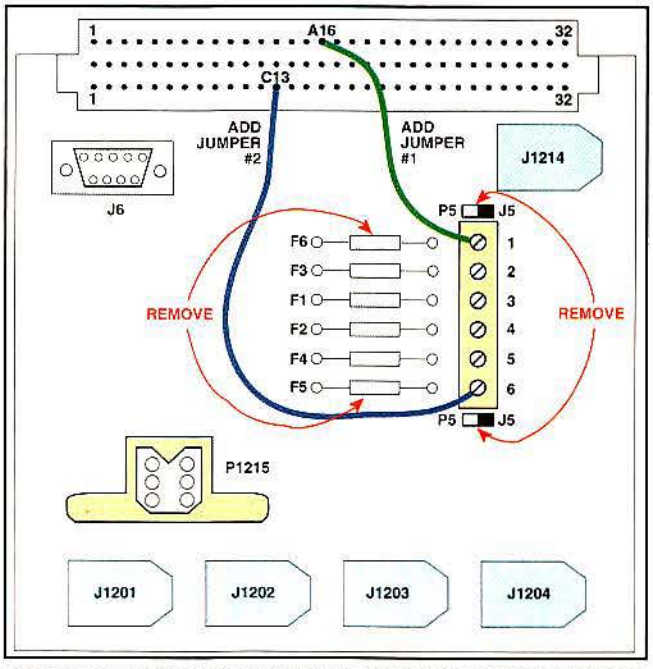


Figure 3. Follow the steps described in the text to modify the Ericsson Mastr IIe/Master III base stations for local control.

The modification is as follows:

First, remove the metal tab from the cabinet to the screw that is just below the L1 designation. (See Figure 1 above left.) This leaves one screw under the L2 designation to serve as ground and to support the terminal block to the cabinet.

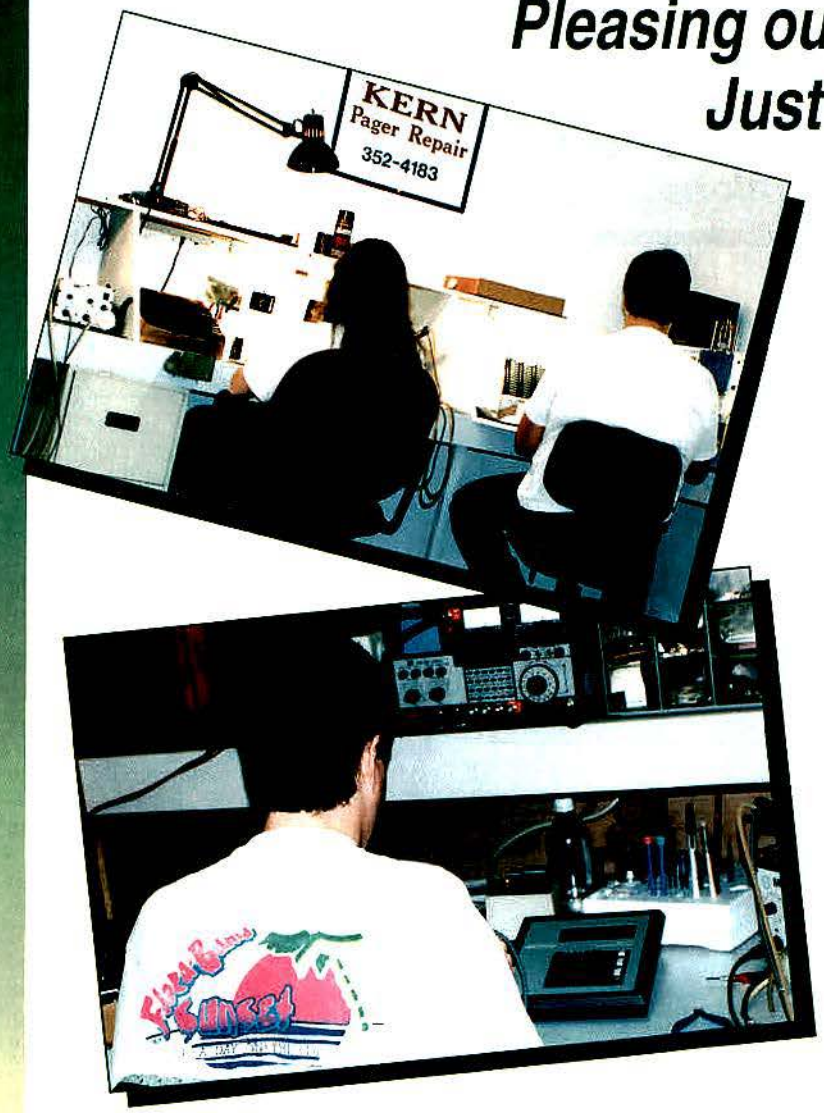
Second, open the cabinet and look for a standard six-conductor, telephone-style modular line cord connected to a modular jack on the back of the WLI. Leave one end connected to the wireline interface board. Trace the cord; it runs to the bottom side of the control board. Slide the drawer out and unplug this end of the cable. On dc remote-type stations, this cable plugs into J901, and on tone-remote stations, J1001.

Route the cable under the chassis and out to the front of the slide-out control drawer. Plug the cable into J812, which is the test connector on the front of the MSF 5000 base station control panel. (See Figure 2 above center.)

Close the drawer, and

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dress the modular cord so that it is not pinched when the drawer is opened and closed for servicing.

See Table 1 on page 56 for the pinout information. Note that the modification brings PTT, Tx and Rx audio out to the side of the cabinet. The modification will have to be temporarily undone if J812 is needed for servicing. Just unplug J812 and plug in the test set.

Note that this modification disables tone or dc remote control. The CP&L stations that were modified are at remote mountaintop sites without wireline control. This configuration allowed the installation of dual-tone, multiple-frequency (DTMF, or Touch-Tone) tone encoders on the repeater as a way of transmitting site alarms.

Mastr IIe and Mastr III stations

CP&L uses VHF highband stations for load control. In the original configuration,

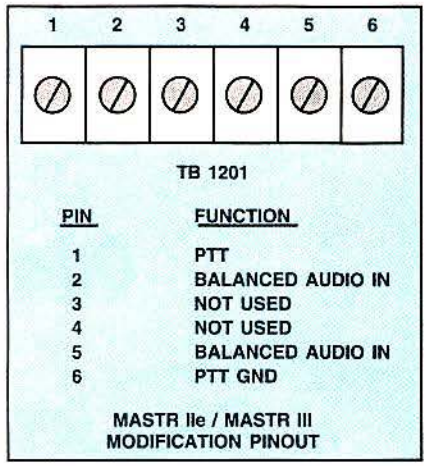


Figure 4. These are the TB 1201 pinouts after modification for local control.

Mastr II base stations were wired to an interface card and controlled over the company microwave system from its energy control center in Raleigh, NC. Last year, the company expanded its coverage in North Carolina and South Carolina. When the Mastr IIe base stations were purchased, it was noted that the new stations did not have provision for local PTT and audio input. The following modification was developed to allow local control.

The existing back plane board on the Mastr IIe/Mastr III has a six-pin terminal block (TB-1201) that can be configured for either two-wire or four-wire tone or two-wire dc control.

Begin the modification by removing the cards in the control shelf that plug into the backplane board. Next, remove the screws holding the backplane board to the chassis. After the board is removed, clip out and discard two fuses, F5 and F6, near TB-1201. (See Figure 3 on page 56.) These fuses are basically zero-ohm resistors.

Solder two jumpers as follows: Connect one end of the first jumper from P3-A16 to TB-1201 pin 1. P3-A16 is remote PTT. Solder the other wire between P3-C13 and TB-1201 pin 6. P3-C13 is digital ground. Remove and discard jumpers J4 and J5. Reinstall the backplane board and cards, and test the installation.

This modification provides local control as shown in Figure 4 above. As with the Motorola MSF-5000 base station, this modification disables remote dc or tone control.

These modifications should prove useful if the need arises for local control of these stations. I would like to thank Gary Brinson of Motorola and Dan Street of Ericsson for their assistance in providing the necessary information and help in developing these modifications.



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Product/services showcase

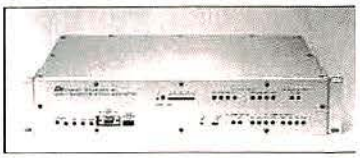
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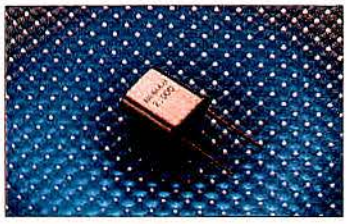


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A new series of high Q bandpass filters offers tunable quarterwave cavities in a variety of diameters for increased Q, selectivity and low loss while suppressing interference from 30MHz to 950MHz. Available from **Microwave Filter**, these filters can be used as preselectors or to clean up spurious transmit signals. Five different sizes are available in single, double and triple cavities. The units have rotating loops and an adjustable resonator for field tuning.

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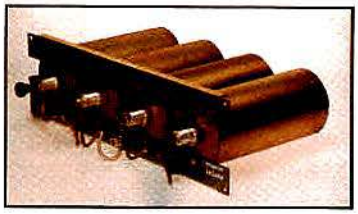
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Scrambling for MicroTAC



Portable telephone security, invisibly embedded into Motorola MicroTACs, is activated with a simple keypad combination. Proven Crypto Voice Plus technology from **Transcrypt International** is compatible with its other scramblers for complete cellular and office security. Call 800-228-0226.

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MasterCharger 6 from **W&W Associates** charges six different batteries simultaneously—with different voltages and capacities, NiCd or nickel-metal hydride. Battery models from different manufacturers can be mixed. One or all six charging positions can be changed to accommodate various transceiver battery types.

Circle (211) on Fast Fact Card



Photovoltaic Power Systems

Solar Electric Specialties' MAPPS systems are stand-alone photovoltaic power systems engineered to support a wide variety of remote power requirements. All MAPPS systems are complete, packaged systems consisting of photovoltaic modules, mounting structures, battery enclosures, wiring and necessary charge-regulation circuitry.

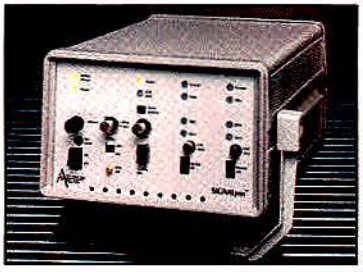
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Two-way Radios

American Wireless two-way communication from **PanaPacific** is available in three different models. All feature the same Motorola craftsmanship and a long list of features, including a talk range of 2–4 miles and performance in buildings with multiple floors. The deluxe AV11C model even has a built-in squelch feature that prevents hearing other users on the channel. For information, call 800-726-2333.

Circle (213) on Fast Fact Card



Paging Decoder

Signalpro. **Advanced Signal's** paging decoder, provides in-depth signal and data analysis as well as a comprehensive set of channel management information. For additional information, please see the ad on page 15.

Circle (214) on Fast Fact Card



Digital Pagers

Samsung's "With Me" digital pagers are available in two-tone colors. The SRP-5210N front-mount numeric is available in VHF and 900MHz. Features include an easy-to-read LCD, 27-message retention, seven random back-up positions and a 12-month warranty.

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Meridian's Pocket Site Selector and Organizer is yours for the asking. Meridian provides space to customers at many antenna sites that cover most of Southern California. For more information or your free organizer, call Rich and Jack Reichler of **Meridian Communications** at 800-400-SITE (7483).

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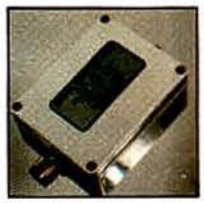


PCS Antennas

The **Decibel Products** division of Allen Telecom Group offers three omni-directional base station antennas for 1,850MHz–1,990MHz engineered exclusively for PCS. Seven sectorized base station antennas are available for 1,710MHz–1,880MHz and 1,850MHz–1,990MHz. Microfill indoor antennas range in size from 4×4" base to 4×8" base and operate in the 1,850MHz–1,990MHz range.

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Product/services showcase



Medium-wave Isolators

Eagle's new medium-wave isolators allow use of existing AM band towers for VHF, UHF or cellular antennas. The isolators can handle 25,000W of medium-wave power, as well as 1,000W of through power. Price: under $200.

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Small Console

DSPatch32 is a small console with big system features, configurable to support 32 lines or operator workstations with touch or mouse operation. External lines may be for radio, telephone circuits, intercom or other use.

Avtec
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Antenna Tester

The easy-to-operate AT-800 rapidly tests 806MHz–960MHz antennas. A back-lit LCD shows VSWR, match efficiency and return loss across the entire band. Instant pass-fail readout, audible indicators and numerous other features are included for installers, technicians and engineers.

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Automation & Monitoring Brochure

Intertech Solutions, a division of **Broadcast Communications**, offers its latest brochure on new communication technologies. Through instrumentation engineering and software programming, Intertech Solutions can help companies automate, monitor and control almost anything.

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Battery Analyzer

Cadex's C4000 battery analyzer services NiCd, NiMH and SLA batteries simultaneously. More than 800 configured adapters are available for batteries for portable radios, cellphones, laptops and other uses. An optional printer generates service reports and labels.

Circle (223) on Fast Fact Card



Noise-attenuating Headsets

The series 6000 noise-attenuating headsets from **David Clark Company** connect to series 6000 push-to-talk two-way radio adapters that connect to a two-way radio. The result is clear, isolated reception and crisp, clear voice transmissions at normal voice levels in noisy environments. Each adapter includes a headset jack, PTT switch, belt clip and custom interface electronics. Both over-the-head or behind-the-head headset styles are available for use with protective headgear.

Circle (224) on Fast Fact Card



Trunking Decoder

The model LT-2 decodes LTR subaudible trunking data plus DTMF. The LT-2 can be used with service monitors or any scanner. The display indicates home repeater and user number plus any DTMF which is transmitted. All decoded trunking data from the repeater being monitored is available on the RS-232 serial port.

Connect Systems
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Circle (225) on Fast Fact Card



Multi-channel Remotes for Midland Radios

The new MCR310 and MCR320 remotes from **CPI** give full control of Midland's Syn-Tech XTR radios, for as many as 99 channels. The remotes provide controls for channel up/down, P-scan, N-scan, add/delete, monitor, PTT, intercom and volume. Other features include 2W of speaker audio, LED channel readout and LED indicators for PTT, scan, monitor and A/D.

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Large-scale Topographic Maps

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Full-duplex Trunking Mobile

E.F. Johnson's new 8630 full-duplex mobile for LTR trunking systems is ideal for business and industrial personnel who need both mobile radio and telephone interconnect service. The 8630 offers a cellular-style handset, expanded variable system and group capacity, and superior audio quality.

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Circle (229) on Fast Fact Card



Full Duplex Radio Modem

The RM2300-40 data link from **EPCOM** is a 25W continuous unit operating at 14,400bps with full duplex capability. For point-to-point or multipoint use at 403MHz–520MHz, it contains two Motorola Radius radios, a duplexer, a switching power supply and a modem.

El Paso Communication Systems
1630 Paisano Drive, El Paso, TX 79901
915-533-5119; fax 915-542-4701

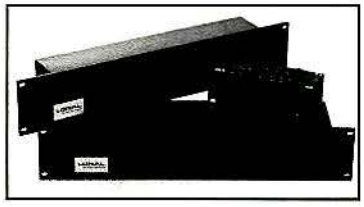
Circle (230) on Fast Fact Card



Full-scan Analyzer

The 486-based COM-120B from **IFR Systems** provides near real-time spectrum analyzer and scope displays with virtually no keyboard buffering. It includes a crossband duplex system, a digitized full-scan spectrum analyzer with optional tracking generator and a PCMCIA memory card. Options include POCSAG, Clearchannel LTR, EDACS and AMPS test capability.

Circle (231) on Fast Fact Card



Cellular Duplexers

Looking for the right duplexer? **Loral Microwave–Narda West** offers a complete line of Microcell. Standard and High Power series duplexers at highly competitive prices with fast delivery. Frequency bands offered are AMPS, GSM and ETACS, with NTACS and ESMR to be available soon.

Circle (232) on Fast Fact Card



Scanning Hand-portable

Scanning hand portables from **Maxon America** are available with four or 16 channels, for UHF or VHF frequencies. Based on the popular SP-2000 design, the radios have enhanced software with priority channel scan and "look back" channel capabilities for increased versatility.

Circle (233) on Fast Fact Card



Antennas, Mounting Hardware & Accessories

Maxrad is a manufacturer of a complete line of antennas for land mobile, cellular, marine and base station applications; mobile, marine and base mounting hardware; and related accessory products.

Circle (234) on Fast Fact Card

MOTOROLA

Pager Point of Sale Warranty

Increase profits with the new Point of Sale Warranty from Motorola! This program enables you to sell Motorola extended warranties directly to your end user customers at a profit. Warranty covers all repairs, including water and physical damage.

Motorola Pager Care Centers

Call 800-548-9954 for details.

Circle (235) on Fast Fact Card

Product/services showcase



Radio-telephone Trunking Board

The **Midian** MOT-RT-8 features include: scans for as many as 16 channels for call channel, incoming calls, or dispatch channels; a 10-city trunking list; four Selcall decode numbers; programmable collect and reset tones; compatability with different terminals; a 10-code scrambler; a 10-number memory dialer; deadbeat disable; and a remote turn on for transmission.

Circle (236) on Fast Fact Card



Trunked/ Conventional 800MHz Radio

Midland International's model 70-9405 is a full-featured, 800MHz LTR-compatible, portable radio. It features 2W of power, a large eight-character alphanumeric display with push-button night light and 10 trunked or conventional systems with as many as 109 groups or 109 conventional channels.

Midland LMR
816-241-8500, ext. 1690; fax 816-920-1144

Circle (237) on Fast Fact Card



Workstation Screens

Modular Communication Systems' consoles and stand-alone workstations for emergency communications feature MODUCOM's "Screenmaker" and "Customizer" software that allows user design of screens for specific operating requirements and applications.

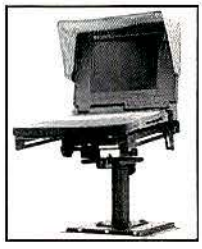
Circle (238) on Fast Fact Card



FDMA Digital Communications Analyzer

Motorola's R-2670 Communication System Analyzer lets the user test Astro digital radios under actual voice conditions, performs bit error rate testing of subscriber units and fixes sites for quantitative measurement. The unit has specialized screens for faster test setups.

Circle (239) on Fast Fact Card



Universal Laptop Mount

The **Mounting Solutions** division of Norlen has added a universal laptop/notebook mount and laptop/notebook accessories to its mobile workforce line. Installation and removal of the laptop is as easy as turning a knob. The mount attaches to any of the company's vehicle mounting platforms for mobile applications.

Circle (240) on Fast Fact Card



Integrated Power System

The **Newmar** Integrated Power System combines the functions of power supply, battery backup, load disconnect, alarm contacts and system monitoring in one complete package. A power supply/battery charger and all accessory components are assembled in a compact 19" chassis. The system is available in 12V, 24V, or 48V models with 475W or 875W ratings.

Circle (241) on Fast Fact Card



Multi-function DTMF Encoder/ Decoder

The NC4000 controls multiple remote operations with status verification reporting of both input and output active functions. It decodes all 16 standard DTMF characters, has an address length of one to eight digits and includes E²Prom memory for nonvolatile storage.

Norcomm
12438 Loma Rica #1
Grass Valley, CA 95945
916-477-8400

Circle (242) on Fast Fact Card

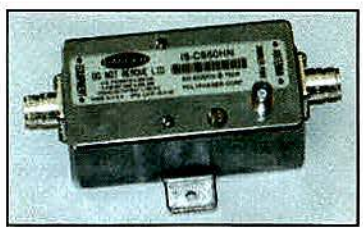


Frequency Counter/ Recorder

The Scout frequency counter and recorder for interference checking records 400 frequencies and 255 hits per frequency over the 10MHz–1.4GHz range. It runs on 10-hour NiCd batteries with nonvolatile memory and can interface with a PC.

Optoelectronics
305-771-2050; fax 305-771-2052

Circle (243) on Fast Fact Card



Coaxial protector for GPS

PolyPhaser introduces a coaxial protector for GPS receivers with active antennas. The IS-MR50LNZ+6 protects in-line amplifiers and GPS receivers, providing optimal protection for dc and RF paths on coax. With positive and reverse voltage protection, it exhibits low loss and low VSWR over a large bandwidth.

Circle (244) on Fast Fact Card



Disguised Cellular/Trunking Cowl Antenna

STI-CO Industries' new 800 series fender-mount disguised broadband antennas cover cellular and trunking frequencies and are exact AM/FM antenna replacements for select Ford, Chrysler, GM and Euro-Asian body styles. Applications include surveillance and cellular customers desiring anonymity. Optional AM/FM broadcast couplers available.

716-662-2680

Circle (245) on Fast Fact Card

SUMMIT COMMUNICATIONS, INC.

Communications Construction and Maintenance Services

Summit Communications is a construction and maintenance operation specifically designed to serve the communications industry. Summit offers turnkey tower construction, cable and antenna testing, antenna installation, maintenance, emergency service and civil construction.

Circle (246) on Fast Fact Card



Procurement Software

Tessco's PC software provides instant access to descriptions and pricing for more than 12,000 wireless products. Build orders, check pricing and delivery, even transmit your order via fax/modem. Complimentary copies for qualified service organizations.

410-472-7000



Paging Channel Monitor

Datanet monitors digital paging activities on multiple channels. Data and graphs show channel air-time loading. It also tests queue delay on each channel and alerts the engineer if a channel fails.

TGA Systems

800-998-8421; fax 800-842-3908

Circle (247) on Fast Fact Card



Tower Ringrotor

TIC Ring allows you to mount your antenna on the outside of your tower at any mounting location. TIC Ring allows you then to rotate your antenna around the tower a full 360° with no tower shadowing. For more information please see the ad on page 80.

TIC General

800-TIC-RING; fax 218-681-8509

Circle (248) on Fast Fact Card



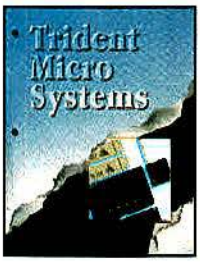
Flexible Coaxial Cable

The LMR-400 low-loss RG-8-size cable delivers 3.9dB per 100 feet at 900MHz, 6.0dB at 2GHz. A foam dielectric, moisture barrier and UV-protected polyethylene jacket provide outstanding outdoor performance.

Times Microwave Systems

800-TMS-COAX

Circle (249) on Fast Fact Card



Wireless System Components

Trident Micro Systems manufactures a variety of products for the wireless industry including trunking controllers, air time loggers and mobile data terminals with GPS. In addition to ESN modules with over-the-air programming, data modems and other components for 220MHz, 800MHz, 900MHz and conventional systems are available in the new catalog.

800-798-7881

Circle (250) on Fast Fact Card



Communication Structures

Valmont Industries manufactures steel structures for communications systems, including tapered tubular monopoles, self-supporting and guyed towers, at plants in North America and Europe. Contact for structure requirements, stocking programs for quick delivery or that special need for a camouflaged communication structure.

Circle (251) on Fast Fact Card

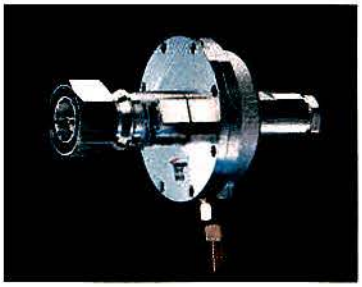


Trunking Option for Test Set

Wavetek's 4015 Stabilock test set is designed for efficient servicing. A wide selection of testing possibilities for communications systems is provided, including a new EDACS trunking option. Integrated selfcheck and autocalibration are standard features.

Circle (252) on Fast Fact Card

Product/services showcase

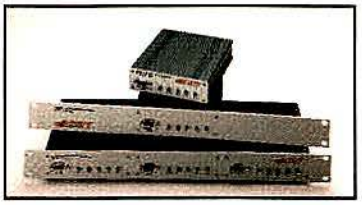


Lightning Protection

Arrestor Plus surge protectors incorporate advanced lightning protection into a Heliax connector, providing a single, integrated, component with multi-strike capability.

Andrew
1-800-255-1479; ext. 29

Circle (253) on Fast Fact Card



Shared Repeater Tone Panel

- Desktop/Rackmount
- 157 Subscribers, 51 CTCSS/106 DCS
- DSP enhanced decode and talk-off rejection
- CW ID per subscriber
- Time and hit counter
- Local/Remotely programmable (DTMF/Menu-driven RS-232)

Communications Specialists
800-854-0547 FAX 800-850-0547

Circle (254) on Fast Fact Card



PSAP Telephone Console

Dispatch centers that handle the critical communications requirements for fire, police and EMS personnel make their purchase selections from a wide range of **Zetron's** line of public safety products. The latest addition to this product line is a modular PSAP telephone console specifically designed for dispatch centers.

Circle (255) on Fast Fact Card



Interconnect Portable

Ericsson introduces the Full Duplex Interconnect Portable providing the convenience of full-duplex telephone interconnect on a trunked system. It allows the user to make and receive outside calls with cellular-like voice clarity. Weighing in at only 8 ounces, it is Ericsson's lightest 800MHz trunked portable.

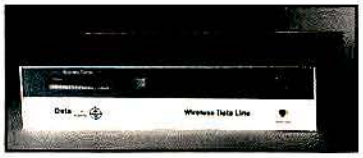
Circle (256) on Fast Fact Card



Heavy-duty Paging Antenna

The new Hustler 12dB omnidirectional paging antenna, model HD12-92040, is now available from **Newtronics Antenna** at a surprisingly affordable price. Featuring a solid mechanical design and a 2" fiberglass radome (150mph wind survival), it offers outstanding fringe area performance and is ac-grounded for lightning protection.

Circle (257) on Fast Fact Card



Lease-line Replacement

The 4WFD-FIP from **DataCom** replaces the wired connection between data centers and/or other leased line sites. Standard features include: full-duplex operation; 100% duty cycle; order wire; and integral six-bay cavity duplexer. The 4WFD-FIP supports as much as V.34 modulation to achieve asynchronous non-compressed data rates as high as 28.8kbs.

Circle (258) on Fast Fact Card



Mobile Work Platform

Gamber-Johnson MO-1000 "air-bag friendly" work platform mounts install in seconds with no tools required. The platform occupies an empty seat, secured by the seat belt. Accessories include the new NotePad universal notebook computer mount.

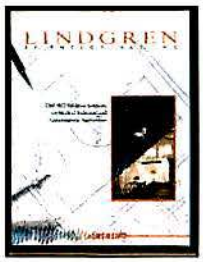
Circle (259) on Fast Fact Card



Trunking Portable

The RTS209 portable from **Kyodo West** is designed to work in the new RTS trunking system. Features include 40-number repertory memory; programmable status reporting; automatic Hi-Low power selection; alphanumeric messaging; call waiting/call retrieval; call restriction; and numeric scratch pad memory.

Circle (260) on Fast Fact Card

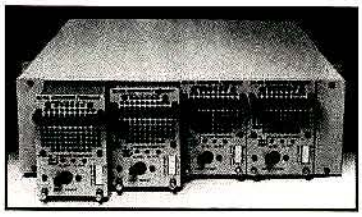


Shielding Systems

Lindgren RF Enclosures is one of the premier manufacturers of shielding systems. Engineering expertise and innovative design solutions enable the company to meet the customers' growing shielding requirements. Lindgren offers a broad choice of shielding systems, including modular rooms, anechoic chambers and R & D and scientific shielding applications.

708-307-7200; fax 708-307-7571

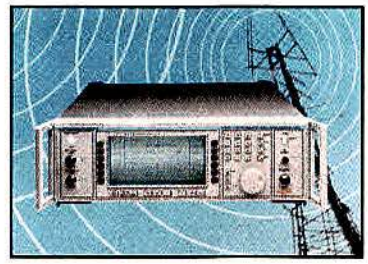
Circle (261) on Fast Fact Card



Modular dc-to-dc Converters

The series 1635 modular converter system occupies only 5.25" of vertical space in 19" or 23" equipment racks and includes as many as four 500W plug-in modules. Each module has an integral paralleling diode, load-sharing capability, and can be inserted or removed without system shutdown.

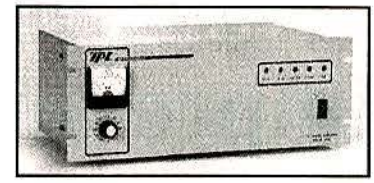
Wilmore Electronics
919-732-9351; fax 919-732-9359
Circle (262) on Fast Fact Card



Signal Generators

The digital and vector modulation capabilities of **Marconi Instruments'** 2050 series signal generators enable rigorous receiver testing during development and production of new major digital systems.

Circle (263) on Fast Fact Card



Power Amplifier

The LMS series power amplifier from **TPL Communications** is a fully enclosed package. It includes power supply, metering, cooling fans, SWR and overtemp protection. Power levels run to 120W, from 35MHz to 960MHz. It is built for rugged use while combining the latest technology into a space-efficient package.

Circle (264) on Fast Fact Card



Signaling Products

The1995 signaling products catalog and updated price list is available from **Vega.** The products described in the catalog are designed to meet signaling requirements—whether for tone-remote or dc remote-control consoles, remote station adapters, tone encoders and decoders or any of a wide variety of system modules (line termination cards, summing amplifiers, line drivers, single-tone encoders and decoders, notch filters and relay cards.)

Circle (265) on Fast Fact Card



Power Attenuators

JFW Industries has a host of new power attenuators ranging from 5W and 10W to 100W and 300W. The 5W and 10W attenuators feature frequency ranges of dc to 2,000MHz and dc to 4GHz. The latest models are 20W and 50W attenuators, dc to 4GHz. For complete specifications and drawings contact:

Mark Burton, JFW Industries
5134 Commerce Square Drive
Indianapolis, IN 46237
317-887-1340

Circle (266) on Fast Fact Card



Mobile Mounts and Accessories Catalog

A complete listing of mobile communications mounts and accessories is available from **Panavise Products.** This full-color catalog displays the entire product line: from two-way radio and mobile data terminal mounts to pedestal, flex and InDash mounts, to PortaGrip portable holders and in-store displays. The best and most complete guide to Panavise products.

Circle (267) on Fast Fact Card

Nov. 7–9, 1995 Moscone Center
WirelessWorld
San Francisco
Expo'95
For more information, call the fax-on-demand system at 800-601-3858.

Mobiles linked as repeaters: Improving the Maxtrac combo

Based on modifications described in a November 1990 article, new circuit modifications improve push-to-talk (PTT) and continuous-tone-controlled squelch system (CTCSS) operation for Maxtrac radios configured as a repeater.

By William Plante, N.C.E.

"How to Link Mobiles to Form a Repeater" by Carlton Tedrick in the November 1990 issue showed how to link two Motorola Maxtrac series radios. I have used this configuration with success, but the design that the article describes has drawbacks, including the false key-up of continuous-tone-controlled squelch system (CTCSS) tone.

If radio A were programmed for CTCSS receive only and if it were on hook, any carrier received would key up radio B, yet no audio would pass from radio A to radio B because the CTCSS prevents it. A modification that I have used improves the linking design with respect to both the false key-up and the use of CTCSS.

Changes include the use of an NPN transistor and a 10,000Ω resistor inside the radio to form a push-to-talk (PTT) switching circuit. This switching circuit is driven from the microprocessor's receiver mute (Rx mute) line. With the circuit, the microprocessor of radio A controls the PTT circuit of radio B. The conversion allows full use of CTCSS control of both radios.

Plante lives in Farmingdale, ME. He is a NARTE-certified engineer (N.C.E.). NARTE is the National Association of Radio and Telecommunications Engineers.

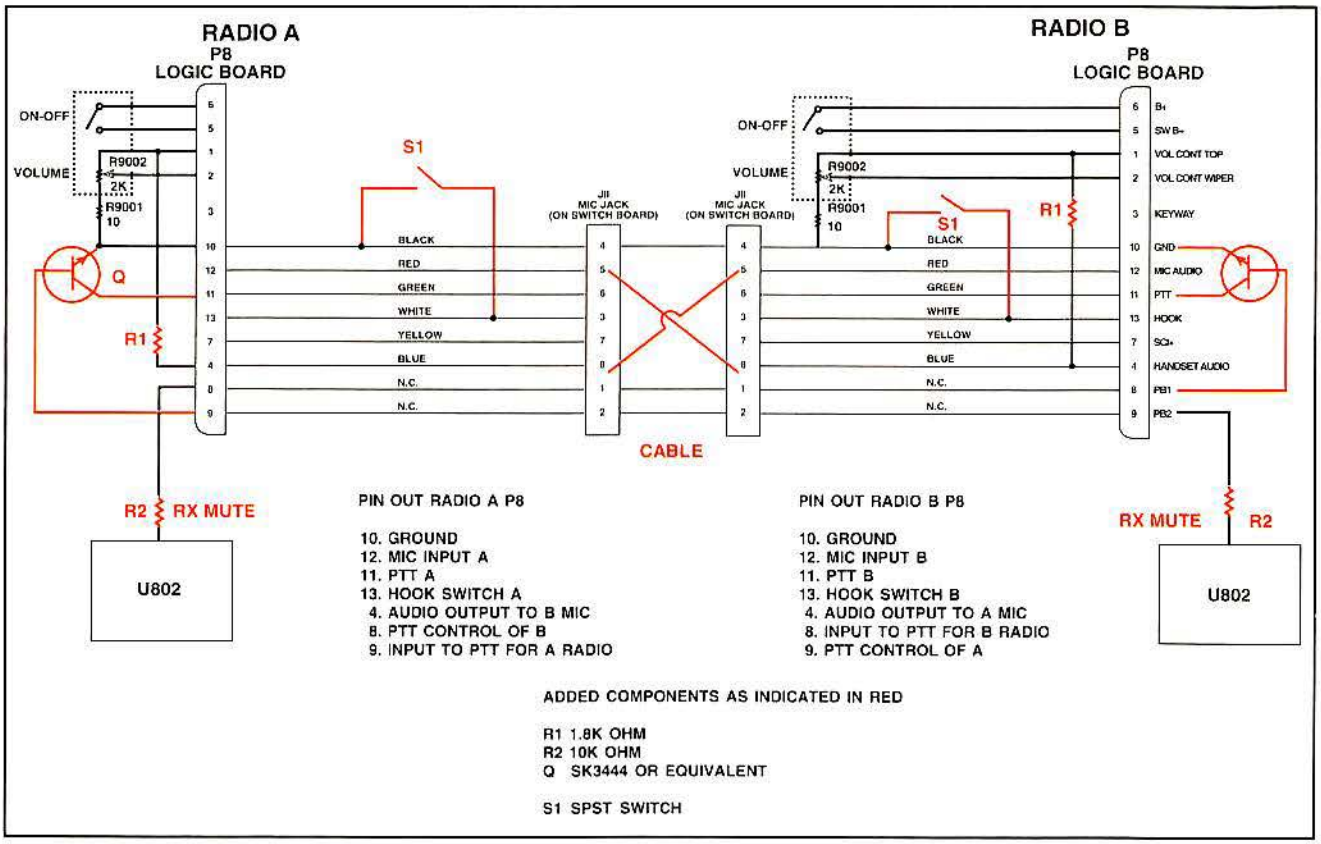
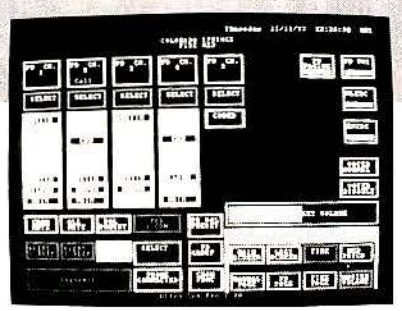
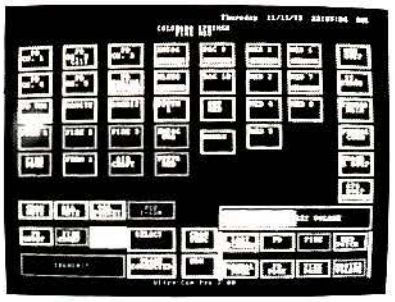
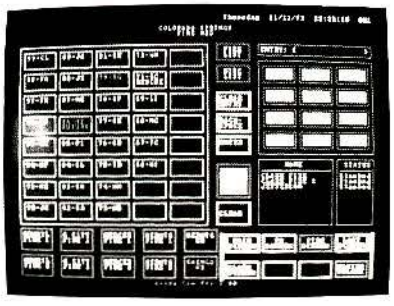


Figure 1. This schematic diagram shows how to modify Motorola Maxtrac 300 radios to work as a repeater with improved PTT and CTCSS control. Components added to the circuitry are indicated in red.

There's more than one reason why MODUCOM Dispatch Consoles are First Choice









Only the Ultra-Com PRO communications workstation lets you design screens for *your* specific requirements, with no changes to software in the common electronics.

- Exclusive *"Screenmaker"* feature lets user design screen's operational requirements
- Exclusive *"Customizer"* feature allows more programmability
- Free software upgrades
- Intel 486 operator-interface (Pentium PC optional)
- Hardware upgrade without firmware changes
- Moducom system design and specification assistance
- Support when you need it

They're talking about us . . .

☐ "For real value, high tech and support, we found that Moducom was hard to beat."
Steve Meer, V.P. Systems Integration, SCC Communications, Inc.

☐ "Modular Communications proved to us that they have the real handle on state-of-the-art."
Bill Smith, Dir. of Communications, Wyoming Highway Patrol

☐ "We have a number of Ultra-Com PRO touchscreen consoles and they have proven to be extremely reliable."
Mike Slavick, Communications Div., Larimer County, CO

Call, write or fax for our Ultra-Com PRO literature package

MODULAR COMMUNICATION SYSTEMS, INC.
13309 Saticoy St., No. Hollywood, CA 91605 • (818) 764-1333 • FAX: (818) 764-1992
Texas Office: 211 King Nicholas, Scroggins, TX 75480 • (903) 860-3660 • FAX: (903) 860-3658

Circle (54) on Fast Fact Card

For example, when the microphone is on hook (or switched by S1), only received signals with a proper tone activate the other radio's PTT circuit. If non-CTCSS operation is required, the operator only has to take the microphone off hook to key the other radio's PTT line with a carrier only. A simple toggle switch (S1) can be added as shown in Figure 1 on page 68 to control hook-switch operation, or a "T" connector could be placed on the microphone jack. (I installed the switch on my unit.) The internal transistor provides a PTT control input to the radio on which it is installed, and the transistor is driven by the other radio. (See Figure 1.) This arrangement has been in operation quite some time and works well.

The pin number for the Rx mute line of U802 for the Maxtrac radio is not shown because the number is different in various models of the logic board. Look for the Rx mute label on the schematic provided for your radio to identify the pin. The 10K resistor connects directly to the microprocessor without any other resistors in series to isolate the Rx mute function from the radio's other functions. I used an SK3444 transistor for the switching, but any comparable transistor can be used. Placing the components within the radio case makes the installation clean. Only two wires must be reversed in the jumper cable connecting the two radios. The audio lines and audio dropping resistor are the same as those described in the original article.

Each radio should be labeled either A or B, because the cross-connection difference requires them to be used in pairs. This labeling has not been a problem in my installation, because radios on different frequency bands are used for radios A and B. In our system, A is VHF lowband; B is UHF.

I did not try other series of Motorola radios, such as the Radius product line, but this conversion also should be adaptable to them. Be aware that any modifications to equipment may void the warranty on that product. As with other equipment modifications, the author assumes no liability or responsibility for results of this modification.

D.T.M.F. SIGNALLING

For interconnect and remote control applications

MODEL NC401



The Model NC401 is a micro-miniature DTMF decoder, designed for selective control of local or remote applications. Measuring .80"W x 1.37"L x .23"H, the NC401 combines three distinct, multi-addressable decoders offering multiple user-configurable functions. All programmed features are stored in non-volatile E2Prom memory and are easily programmed by means of a conventional DTMF encoder or the Model NC500 Universal/P.C. programmer. This highly engineered decoder is ideal for portable radio applications having limited space for accessories. The NC401 comes complete with micro-miniature 14 pin header and 12" color coded cable assembly. For FREE detailed information ask for the NC401 user's manual.

MODEL NC409



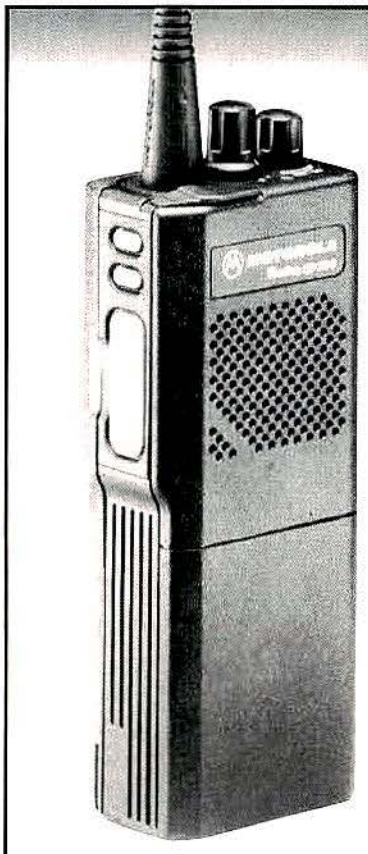
The Model NC409 is a DTMF ANI/Alarm status encoder and companion product to the Model NC401 DTMF Decoder designed to automatically or manually generate any of the 16 DTMF characters. The NC409 features 15 memory locations of up to 30 digits each plus last number redial and multiple user-configurable functions. Programming is easily performed by means of a 12 or 16 button "X-Y" keypad with common ground or the Model NC500 Universal/P.C. programmer. The NC409 measures .85"W x 1.36"L x .165"H and comes complete with micro-miniature 14 pin header and 12" color coded cable assembly. For FREE detailed information ask for the NC409 user's manual.

For detailed information or product catalog call 1-800-874-8663 or Fax 916-477-8403

NORCOMM™ DATA SIGNALLING PRODUCTS

12438 Loma Rica Dr., Grass Valley, CA 95945

Circle (55) on Fast Fact Card



Radius®

PORTABLES, MOBILES BASE STATIONS REPEATERS

We've earned a good Radius business with a large inventory, good prices and quick service. We would like to earn your business . . . please call today.

TOLL-FREE (800) 877-7979

HENRY RADIO

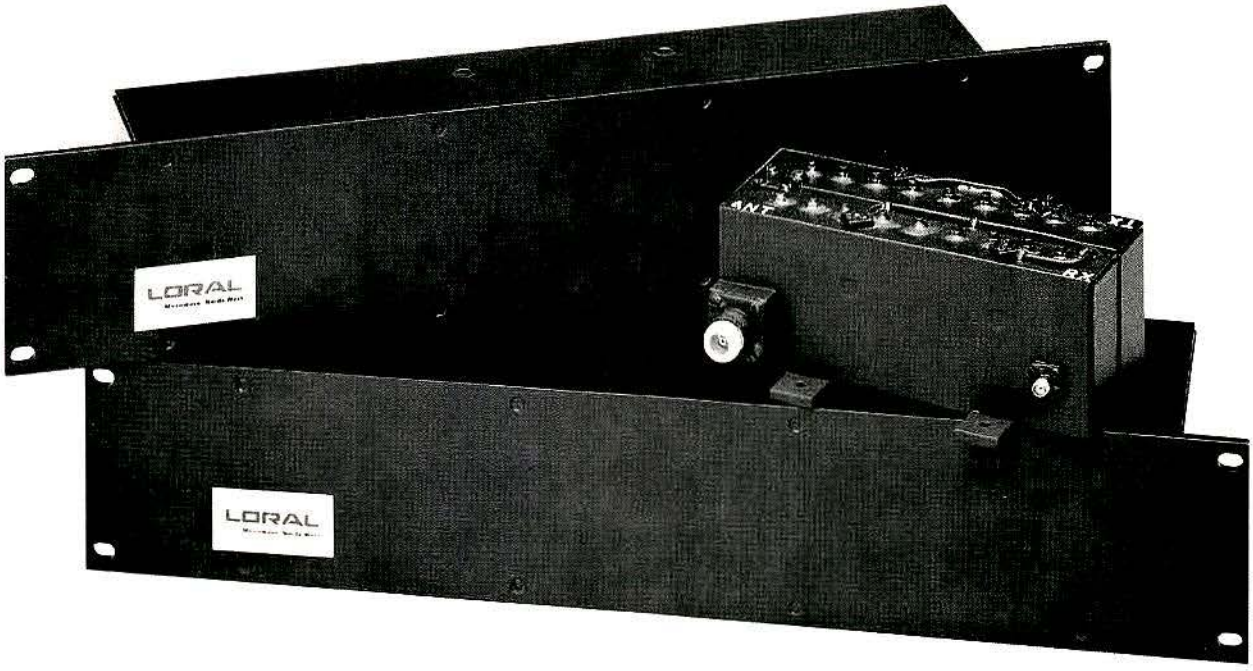
2050 South Bundy Drive
Los Angeles, CA 90025

Phone (310) 820-1234
FAX 310-826-7790

Circle (56) on Fast Fact Card

New from Narda West

LOOKING FOR THE RIGHT DUPLEXER?



- **Why use a 19" rackmount duplexer in a Microcell application?**
- **Looking for a more efficient solution for your Wireless Data/CDPD requirement?**
- **Is peak power handling becoming an issue in your high capacity sites?**

Answers are waiting for you in Narda West's new line of duplexers – the Microcell, Standard and High Power series. No longer do you need to settle for a compromised solution.

Performance by Design.

Narda West duplexers optimize channel-to-channel isolation and minimize insertion loss. For example, isolation in the high power series is 75 dB minimum, with 90 dB typical. (See table for more performance data.)

Great Pricing and Delivery.

All three duplexers are available in quantity and on short delivery cycles, usually within a few weeks. Prices are not only highly competitive, but typically save you 10-30%, depending on the product series.

For more information on the right duplexer for your job, call or write: Loral Microwave-Narda West, 11040 White Rock Road, Bldg. 200, Rancho Cordova, CA. Tel: (916) 638-5500. Fax: (916) 638-8682. Ask for Brian Wixon on extension 221.

	COVERAGE	DIMENSIONS	WEIGHT	CHANNEL-TO-CHANNEL ISOLATION	INSERTION LOSS	POWER HANDLING
Microcell	AMPS GSM	6.5"x2.45" x 2.80" max deep	3-1/2 lbs	50 dB min 60 dB typical	1.0 dB max 0.6 dB typical	20W CW 200W Peak
Standard	AMPS GSM	19" rack x 2U x 3.7" max deep	5-1/4 lb	75 dB min 85 dB typical	0.8 dB max 0.5 dB typical	400W CW 400 W Peak
High Power	AMPS GSM	19" rack x 2U X 5.4" max deep	8-1/2 lb	75 dB min 90 dB typical	1.0 dB max 0.6 dB typical	500W CW 10KW Peak

LORAL

Microwave-Narda West

Circle (57) on Fast Fact Card

(continued from page 8)

is 1.55 times the voltage of the forward wave. This function of combining voltages is how standing waves produce higher voltage stresses on transmission lines. The higher the standing wave ratio, the higher the reflection coefficient and the higher the peak stress voltages on the line. A VSWR of infinity would produce a reflection coefficient of 1, and because the voltage of the reflected wave would equal the voltage of the forward wave, the maximum combined voltage of the two in phase would be twice the voltage of the forward wave alone. The combination of the two at 180° out of phase would be zero voltage. Thus the VSWR would be 2:0, or infinity.

Because the perfect short circuit or perfect open circuit does not exist, the VSWR can never reach infinity. However, it can be very high, and as a result it can produce very high peak voltages at points where the voltages of the forward and reflected waves combine in phase.

To determine the angle of reflection at any point of the transmission line, use Equation 3. Then, to find the relative voltage of the standing wave at that point,

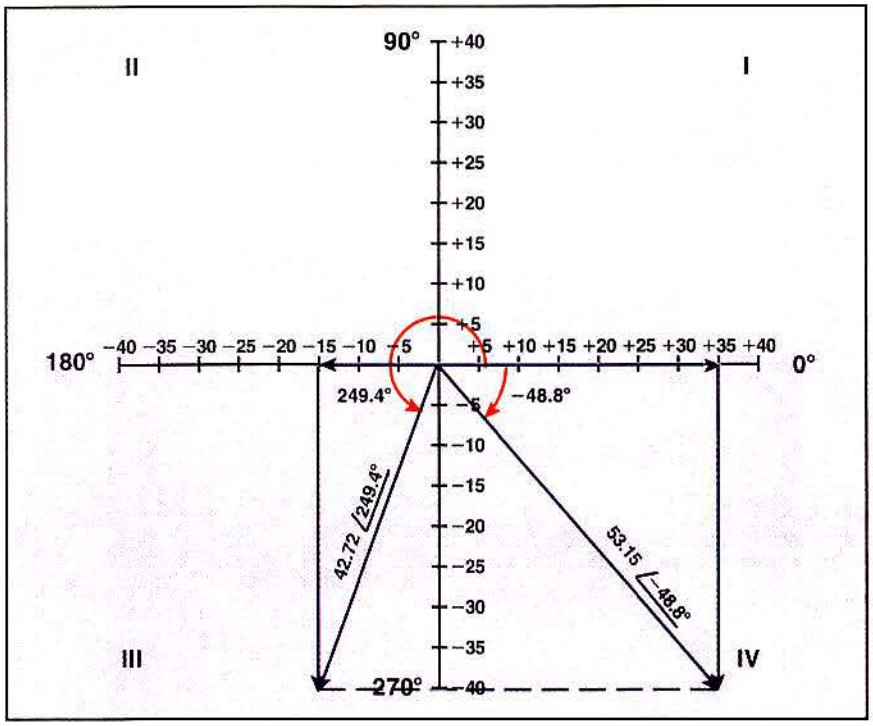


Figure 3. Impedance is converted to polar form from the rectangular form. The resultants in polar form are then used to calculate the reflection coefficient and the angle of reflection. See text and equations for the procedure.

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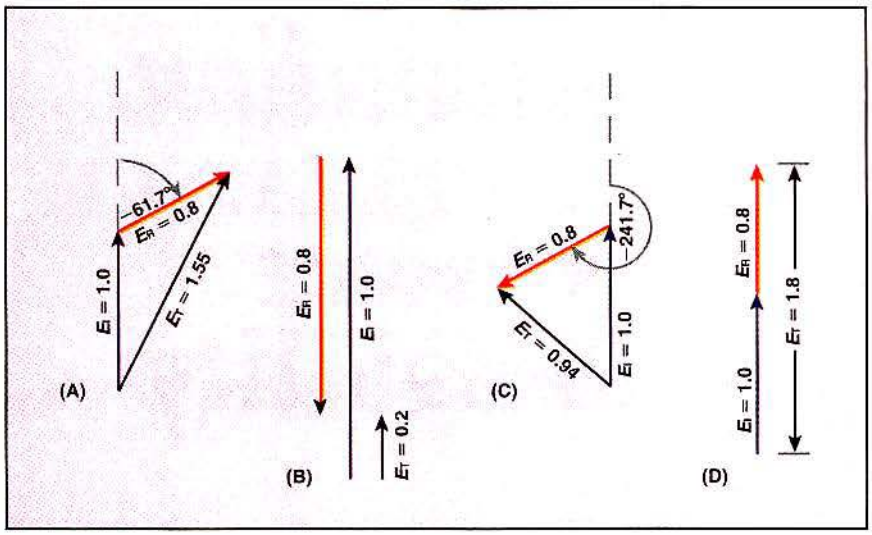


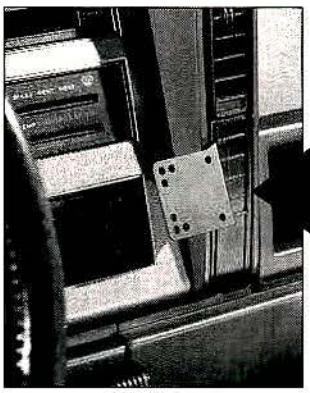
Figure 4. This phasor representation of the incident and reflected waves shows how the phase relationships and magnitude produce a varying level of standing wave.

substitute this angle (phi or ϕ) into Equation 4. Theta (θ) in Equation 3 is the reflection angle at the load.

Figure 4 above shows how the reflected and forward waves combine at various points. The phasors in examples A and C occur at 0.25λ apart on the line. Also, examples B and D are 0.25λ apart. Note that in example B the phasors are 180° out of phase and subtract directly. This produces the voltage minimum on the standing wave. In example D, the phasors are 0° apart (exactly in phase) and therefore add directly. This summing produces

Table 1. Complex load impedance, where (Z_L) = 20 − *j*80 ohms. Reflection coefficient (Γ) = 0.8 at an angle of −61.7° at load. VSWR = 9:1.

Distance from load (λ)	Angle of reflection (°)	Magnitude of standing wave
0	−61.7	1.55
0.025	−79.9	1.39
0.050	−97.7	1.19
0.075	−115.7	0.97
0.100	−133.7	0.73
0.125	−151.7	0.48
0.150	−169.7	0.26
(MIN) 0.1645	−180	0.20
0.175	−187.7	0.23
0.200	−205.7	0.45
0.225	−223.7	0.70
0.250	−241.7	0.94
0.275	−259.7	1.16
0.300	−277.7	1.36
0.325	−295.7	1.53
0.350	−313.7	1.66
0.375	−331.7	1.75
0.400	−349.7	1.79
(MAX) 0.4145	−360	1.80
0.425	−367.7	1.796
0.450	−385.7	1.76
0.475	−403.7	1.67
0.500	−421.7	1.55



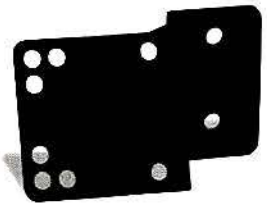
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the voltage maximum on the standing wave.

Table 1 on page 74 shows the relative magnitude of the standing wave at various points on the transmission line. Note that the minimum and maximum values fall exactly 0.25λ apart. Figure 5 at the right shows a plot of the standing wave that represents the load of 20 − *j*80 ohms.

Calculating impedance (Z)

The impedance (Z) at any point on a line can be calculated from the Γ and the reflection angle. First, Γ must be converted to the complex form of $R \pm jX$. $R = \Gamma\cos(\phi)$ and $jX = \Gamma\sin(\phi)$. Use Equation 5 to calculate Z. Remember, Γ must be in complex form ($R \pm jX$).

For example, using Table 1, calculate the complex impedance at a point 0.375λ from the load. Here the angle of reflection (θ) is −331.7°. The calculations are shown in the box on page 78. Note that Z_N is normalized impedance such as you would see on a Smith chart. To get the impedance in a 50Ω system, multiply by 50, as shown on page 78.

Return loss

Return loss can be easily calculated

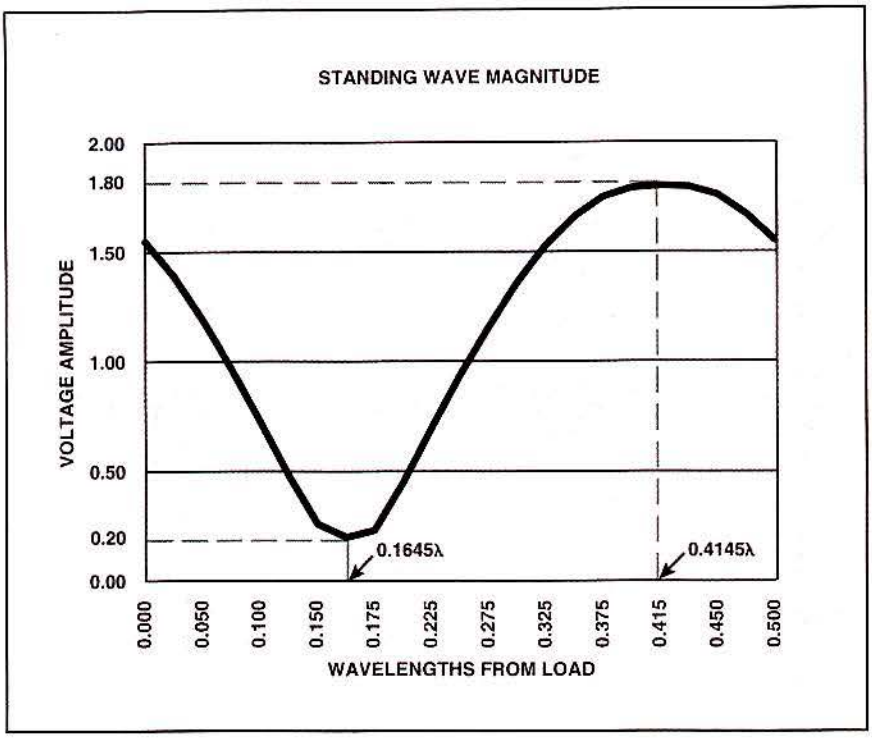
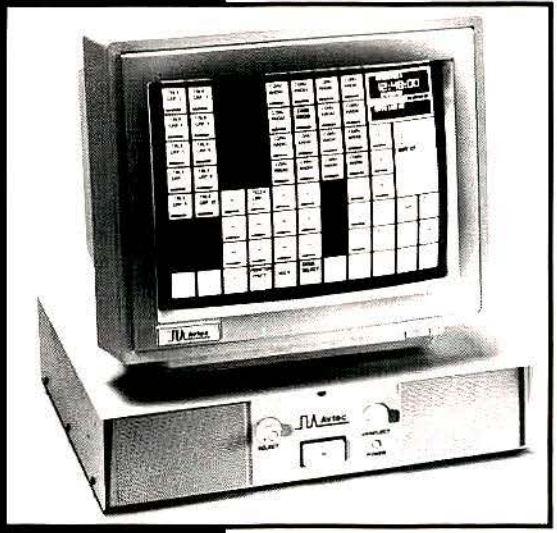


Figure 5. The results of Table 1 produce a graphic representation of the standing wave on the transmission line loaded by the 20 − j80 ohm load. Note that the voltage minimum and maximum occur at 0.25λ apart.

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from reflection coefficient. For example, the reflection coefficient of 0.8 as used in the above example would correspond to a return loss of 1.94dB. Use Equation 6. The percentage of reflected power can be determined from Equation 7. For example, a reflection coefficient of 0.8 is equivalent to 64% reflected power. If a directional wattmeter indicated a forward power of 100W, then the reflected power would indicate 64W.

Summing up

As you can see, there are many ways to represent the same characteristics on a transmission line. There are situations when it is easier or better to indicate mismatch in terms of Γ, VSWR, percentage reflected power or return loss. At other times, it is simply a matter of personal preference. No matter how it is represented, this should help you to understand how the various units of measure are interrelated.

As usual, a computer program is available that will compute the reflection coefficient and reflection angle at the load or at any other point on a transmission line. A second program deals with VSWR and various conversions. Both programs are available on a single diskette for $7.50 plus $2.50 for shipping and handling. The programs run under MS-DOS on an IBM-compatible PC. Specify 3.5" or 5.25" diskette. You may write the author at 204 Tanglewylde Drive, Spartanburg, SC, 29301-2949.

'Til next time ... *stay tuned!*

Reflection coefficient (Γ) = 0.8 @ – 331.7°

$R = 0.8\cos(-331.7°) = 0.8(0.88) = 0.704$

$jX = 0.8\sin(-331.7°) = 0.8(0.47) = 0.376$

$\Gamma = 0.704 + j0.376$

$$Z_n = \frac{1+(0.704+j0.376)}{1-(0.704+j0.376)} = \frac{1.704+j0.376}{0.296-j0.376} = 1.59 + j3.28$$

$Z = 50(1.59 + j3.28) = 79.5 + j164$

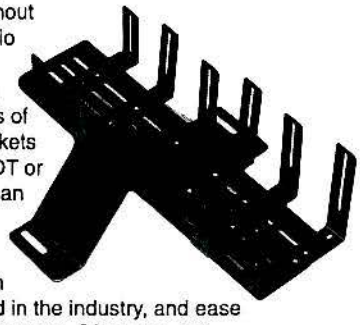
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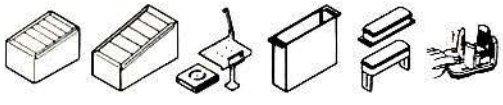
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The legislative process

By Robert H. Schwaninger Jr.

On May 9, a group of specialized mobile radio (SMR) system operators who fear for the future of their businesses descended on Capitol Hill, armed with a message for their representatives and senators: "No forced frequency migration and no auctions."

Organized by the Personal Communications Industry Association (PCIA), the group of independent operators took the action to oppose an FCC proposal to force an exchange of frequencies to clear contiguous spectrum for a proposed auction of 50-channel blocks of 860MHz spectrum within metropolitan trading areas (MTAs).

During the meetings with Congressional staffers and elected officials, the independent SMR system operators made their case, pointing out the harm that frequency-swapping and auctions would bring to small businesses and to their hundreds of thousands of customers. The operators also argued that any auction would be a private affair between the FCC and Nextel Communications, the only entity that appears to be in a position to bid.

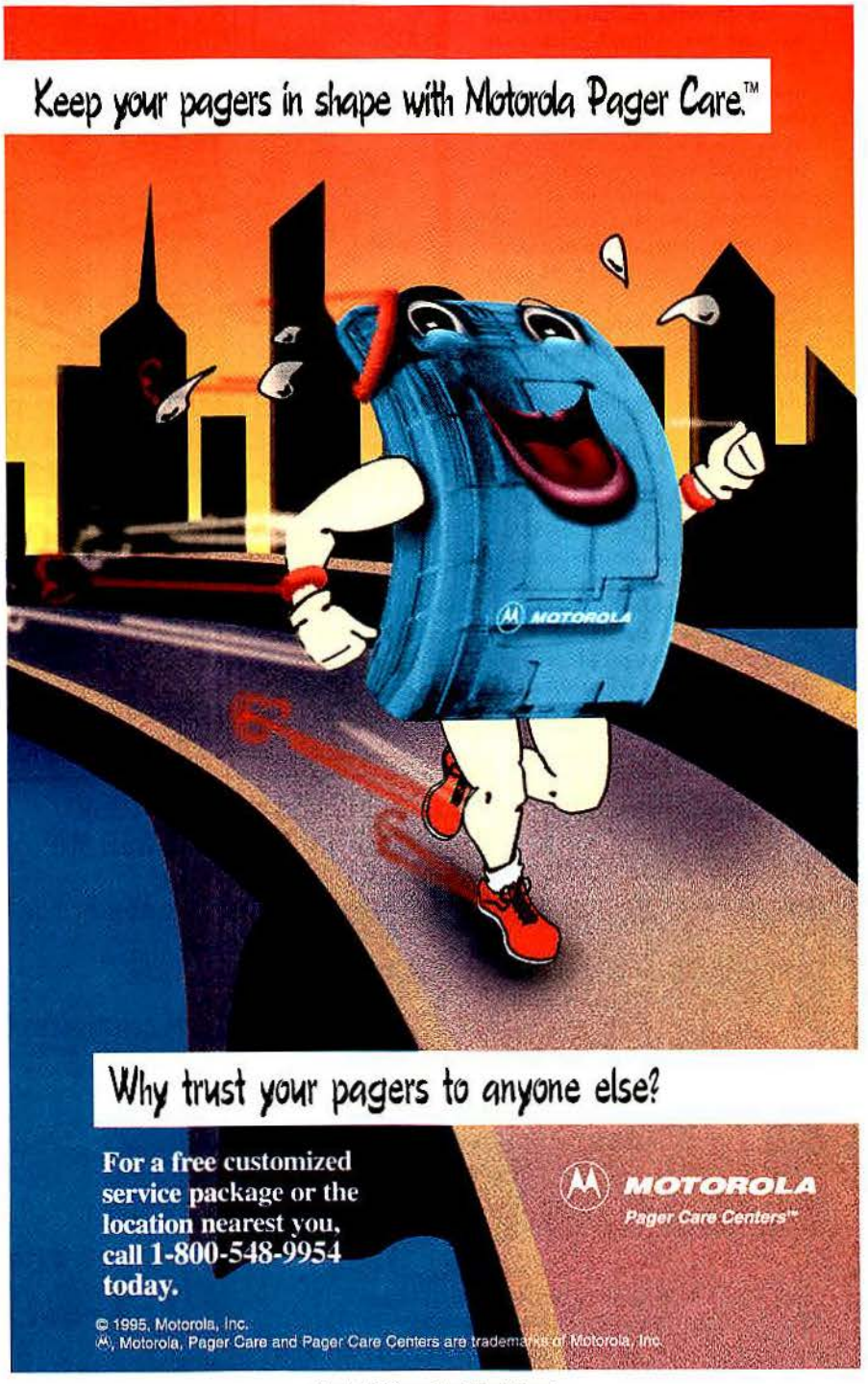
If you have never had the pleasure of visiting a congressional office, then you have never truly seen the legislative process at work.

As a participant in the visits, I noted that it was business as usual on the Hill. Congressional aides feigned deep concern, although few had any idea as to the nature of the problem prior to the meeting. All pledged the support of their bosses, providing that such support would not cause them any real political difficulty.

If you have never had the pleasure of visiting a congressional office, then you have never truly seen the legislative process at work. The legislative process is not, in fact, the speeches from the floor of Congress shown by C-SPAN, it is not the small packs of politicians crowding around a microphone to produce sound bites for the media mongrels, and it certainly is not any tight collection of ideology called a "contract" or a "new covenant."

To view the legislative process, go into one of the huge congressional office buildings, such as Rayburn or Cannon or Hart. These monolithic structures are honeycombed with offices and committee rooms. Senators' and representatives' offices are indicated by the display of state seals that indicate fidelity to a district or state. Finding the correct office can be the most difficult part of your visit as you try to determine which building, which floor and which room

Schwaninger, *MRT's* regulatory consultant, is a partner in the law firm of Brown and Schwaninger, Washington, DC. He is a member of the Radio Club of America.



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contains your elected official.

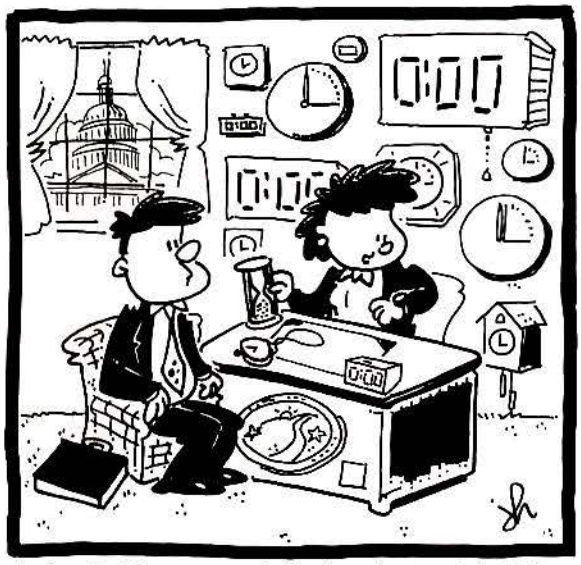
As you pass through the right office door, the first thing you notice is that the office is decorated with local memorabilia. People from Iowa might find a sculpture made out of corn husks. Constituents from Idaho always find a tribute to the spud. Folks from Missouri find at least one mule in every Democrat's office. The truth is, the offices often look as though they were decorated for Founder's Day by a high school art class.

The friendly receptionist (and boy, are they friendly) asks you to take a seat until the aide is available. That's when you notice the furniture, which often looks as though it had been bought second-hand from a dentist. The ambiance is somewhat cheesy and hokey, but still, you are sitting in the outer office of a powerful elected official, so you shrug it off.

While sitting there, waiting for the aide to appear, you can leaf through the brochures that explain tours of Washington. Most congressional offices serve as a kind of travel guide for constituents who are visiting as tourists instead of coming with an axe to grind. Tickets to sit in the Senate gallery or to tour the White House are often distributed right from those offices.

If you do not want to read about tours of Mt. Vernon or Arlington Cemetery, you can watch the people who pass in and out of the office. The offices are constantly abuzz with activity, with this group exiting after having discussed that matter with some aide and another group entering to seek support for another issue. It's a wonder that the offices do not have number machines, like a bakery, that say, "Now Serving No. 86."

Sometime near the appointed time, an aide with glad handshakes and big smiles will appear. Be prepared. Aides are usually young. I mean "what-the-hell-can-this-pup-know-about-life"-young. Most are in their twenties and have obviously practiced looking concerned in front of a mirror for weeks.



They will lead you to some room to sit on even cheesier furniture and will give you about 15 minutes to convince them of your position. Mind you, they rarely understand the issues or the facts or the vernacular of your business or much else about why you showed up on their doorstep, but still you get a whole 15 minutes to explain all of that. If you are good and have practiced your routine, you will be able to boil it down quickly and tell them what you want their bosses to do.

What they really want to know is the following:

(1) In 25 words or less, What's your problem?

(2) In 10 words or less, What do you want?

(3) In 50 words or less, If we help you, what's the downside?

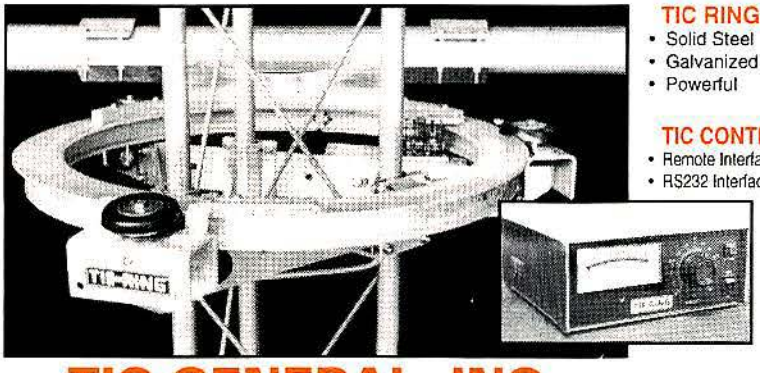
They also will want to know that you are from their district, employ people and vote (or know someone who once did).

It is not unusual for them to ask for a draft letter that the congressman might edit, sign and send to the agency, branch, division or commissioner of your choice. That way, they can make you happy while spending as little time as possible on the chore. Do not be offended by this request. The letter you write for them is probably more accurate and says what you want better than one that the congressional office would draft on its own.

After 15 minutes has passed, the aide gets up, signaling that your time is up. More handshakes and more back slapping. Then they promise to "get right on it," and you promise to send them more

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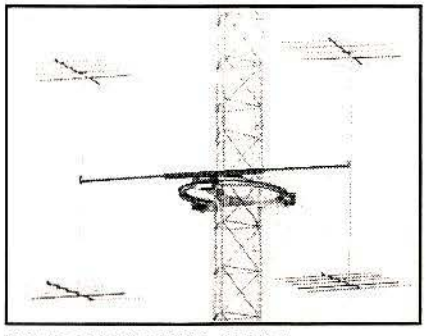
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information. If the planets are arranged properly and your request is not lost in the shuffle, you will receive a letter from the congressional office that expresses the congressman's (a) support, (b) opposition, (c) concern, (d) grave doubts, (e) interest in, (f) request for, or (g) study of, some issue. Combinations of the foregoing are possible.

If the aide has done her job properly, you go away believing that your elected official truly cares about your problem and will help in solving it. (Notetaking by the aide often adds to this impression.) If the aide fails, you exit believing that (a) the trip was a waste, or (b) the aide is a fool, or (c) the congressman does not give a hoot and knows even less or (d) all of the above.

Although these experiences often feel like an impromptu charade, the fact is that they are valuable. When enough congressional offices have sent enough letters expressing their approval or disapproval for a particular rule or issue, the agency will listen. One or two such letters are usually not enough to worry about. But if the FCC chairman gets 50 or 60, it becomes increasingly difficult to ignore the sentiment of the correspondence.

When enough congressional offices have sent enough letters expressing their approval or disapproval for a particular rule or issue, the agency will listen.

As I once again participated in one of these efforts with a number of California SMR system operators, I was impressed with the deft handling of the matter by Senator Boxer's aide, who asked the right questions and did not give the impression that he was trying to get rid of us. One congressman's aide appeared to be bored and anxious to get over with it. Yet Congressman Thomas was genuinely interested and offered to help.

Having once again experienced the true legislative process, I was left with the same impression as usual. The exercise probably was worthwhile, but about as fulfilling as remembering to put milk on the grocery list. I always am pleased to see the welcoming attitude of the elected officials, but I feel let down by their mechanical approach to the process. Although their constituents might be suffering some great threat, for the congressional offices it is "business as usual."

The next time you come to Washington, make an appointment to visit your senator's or representative's office. Just sitting on the bad plaid couch in the reception area and listening to conversations will be a more revealing civics lesson than any you have ever received. It personalizes government and takes away much of the mystique. It makes you aware of the pressing schedule maintained by those who are professionally concerned.

It is also a great way to get tour tickets.

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Motorola announces InFlexion two-way messaging protocol

Motorola's Advanced Messaging Systems Division, Ft. Worth, TX, announced its InFlexion two-way advanced messaging protocol at COMDEX/Spring. The protocol will offer voice and data messaging at speeds as high as 112,000 bits per second (bps) on a 50kHz nationwide channel.

InFlexion is a member of the Flex family of high-speed transport protocols, which is composed of Flex, ReFlex and InFlexion. Each offers different services, capacity levels and price points. InFlexion builds upon the core capabilities of ReFlex and will support ReFlex 25 products. It is on schedule to begin field tests late in 1995.

The first InFlexion-based product, VoiceNow, will be offered by PageNet. VoiceNow is a service that turns a pager-size device into a palm-size, portable wireless answering machine. VoiceNow will deliver messages in the sender's voice to a portable device anywhere in the United States. Voice compression technology allows messages as long as four minutes to be played back whenever the customer chooses. The network supporting VoiceNow also will be capable of transmitting data messages at speeds as high as 112 kilobits per second (kbs).

Glenayre Technologies, Charlotte, NC, has been licensed worldwide by Motorola to design and manufacture messaging infrastructure equipment for the narrowband PCS market incorporating the InFlexion voice and data protocol. Glenayre's products will include switches, network control, base stations and field receivers.

Glenayre and PageNet have signed a memorandum of understanding to beta-test PageNet's VoiceNow with Glenayre's inftrastructure equipment in San Francisco. Testing will begin this year.

Midland to move two-way radio manufacturing to North America

Midland International, Kansas City, MO, is proceeding with plans to manufacture the Midland Syntec XTR two-way mobile radios in North America. Midland has reached an agreement with its overseas supplier to transfer responsibility for finished goods manufacturing. The supplier also has agreed to provide technical support and assistance with the technology transfer and startup.

In other Midland news, Midland International has signed a letter of intent with an international group to purchase the assets of the Midland consumer radio division and to purchase a license for the use of the Midland name and trademark in connection with the sale of communications and other types of electronic equipment for the consumer market.

Motorola to offer one-stop shopping for PCS system deployment

Motorola's Pan American Market Division, Arlington Heights, IL, plans to offer comprehensive services that will provide new PCS operators one-stop shopping for infrastructure equipment, site acquisition and site preparation.

Motorola's Genesis Precision Constructed Services will provide solutions to build PCS sites quickly and cost-effectively. Among the services Genesis will provide are: RF planning and configuration; site acquisition services, including site planning, lease agreements, zoning and FAA applications (where necessary); site construction and civil construction work; microwave band clearing; and equipment installation, testing and system optimization.



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TGA PRISM II paging systems are designed to meet the standards used by international telephone administrations such as:

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Circle (68) on Fast Fact Card

Andrew to offer fax-on-demand information service

Andrew, Orland Park, IL, is now offering "Answers from Andrew," a new, automated fax-on-demand system that is available to customers 24-hours-a-day, seven-days-a-week.

The system is a blend of interactive voice and fax, and it provides a wide variety of information, including product information, technical documents and news publications. Anyone with a Touch-tone phone and a fax machine can access the system and order as many as five documents by entering a document number.

Customers can try out the system by calling 800-861-1700. International callers should dial 708-873-3615.

In other news, Andrew has opened two new equipment shelter manufacturing plants. One is a 100,000 square-foot facility in Newnan, GA, a suburb of Atlanta; the other is a 54,000 square-foot plant in Sacramento, CA.

Opening of the facilities was spurred by increased customer demand for the shelters worldwide.

PageNet, CompuServe join to develop wireless E-mail services

As part of a new initiative dubbed "CompuServe Stay in Charge," CompuServe and PageNet, Dallas, plan to provide CompuServe members with a variety of new services that will be available in the latter half of 1995.

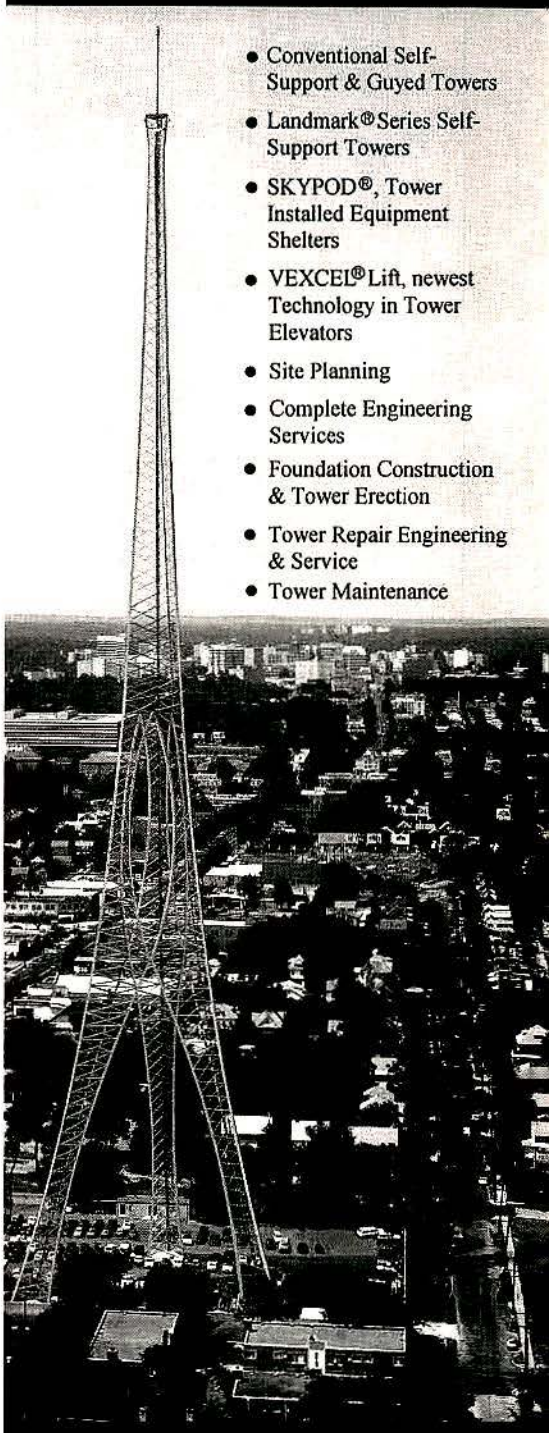
Through the service, CompuServe members will be able to have messages forwarded via PageNet's wireless network. Members will have a filtering option that will allow them to establish a profile of critical mail that filters their CompuServe mail and forwards only critical messages to the pager. They also will have the option to be notified via pager whenever a message arrives in their mailbox.

Yet another option for CompuServe members will be to send E-mail directly to PageNet alphanumeric pagers of fellow members and, potentially, to all PageNet alphanumeric subscribers.



Circle (69) on Fast Fact Card

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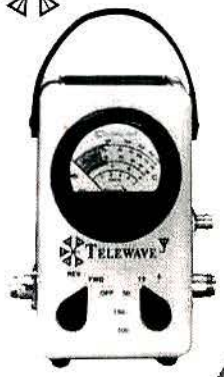
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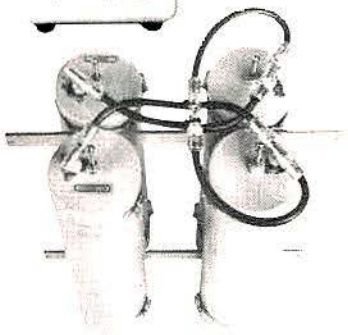
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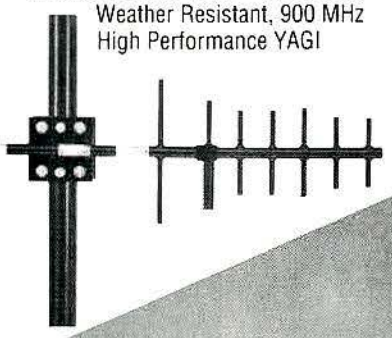


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News

Bird offers reward for vintage thruline wattmeters

Bird Electronic, Cleveland, has launched "Quest 43" to locate the oldest working model 43 thruline wattmeter. The contest is in honor of Bird's recent production of the 250,000th model 43. Rewards for vintage wattmeters include a 24 KT gold-plated model 43, new wattmeters and $250–$1,000 gift certificates.

Entries must be received by January 31, 1996. Winners will be formally announced at next year's International Wireless Communications Expo, April 24-26, 1996.

Call Bird Electronic at 216-248-1200 for more information and an entry form.

NEC strengthens commitment to wireless industry

Nec America, Irving, TX, has realigned its mobile radio products operations into three separate business units to solidify its position for growth in the wireless industry.

The Wireless Message Terminals Division was formed to focus on text messaging, such as pagers and future narrowband personal communications service (PCS) products.

The Wireless Voice Terminals Division will focus on two-way voice devices, such as cellular telephones and future broadband PCS. A third group, the Wireless Communications Division, will support the other two divisions where their needs overlap.

Roamer One, Midland sign agreement for 220MHz radios

Roamer One has signed an agreement with Midland International, Kansas City, MO, providing for an alliance in the loading of the Roamer One 220MHz specialized mobile radio (SMR) network. Midland has been granted exclusive sales rights for all 220MHz radios bearing the Roamer One logo and will be responsible for their distribution throughout its dealer organization.

Pro-Fit offers toll-free number

Pro-Fit International, Bloomington, MN, now offers customers a toll-free number: 800-388-0073. Pro-Fit manufactures custom vehicular mounts.

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Tessco to become national distributor for several companies

Tessco, Sparks, MD, has become a national distributor for the following companies:

Hewlett-Packard, Palo Alto, CA—Tessco will stock the HP 200LX, a full-function DOS computer, and the Omni-Book 600, a color subnotebook computer, as well as accessories to adapt both computers for mobile data transmission.

Motorola—Tessco will stock the Envoy and Marco models of wireless communicators from the Motorola Wireless Data Group, Schaumburg, IL.

Ora Electronics, Chatsworth, CA—Tessco will stock batteries, eliminators, chargers, conditioners, cases, hands-free kits and mobile data equipment for all the most popular cellular phones.

Centurion International, Lincoln, NE—Tessco will stock two-way batteries and two-way and cellular replacement antennas for all of the most popular radios and cellular phones.

Ericsson, Uniden sign cross-licensing agreement

Ericsson, Lynchburg, VA, and Uniden, Ft. Worth, TX, have signed a technology cross-licensing agreement that will allow the two companies to develop products that are interoperable with LTR, ESAS, EDACS and PCN trunking systems. Uniden also will be authorized to market EDACS and PCN systems.

Decibel moves to new building

Decibel Products, Dallas, a division of Allen Telecom Group, Cleveland, has outgrown its present five-building, 195,000 square-foot complex that it has occupied since 1960 and has expanded into a 260,000 square-foot building about two miles away. The new address is 8635 Stemmons Freeway, Dallas, TX 75247. The phone numbers will remain the same: 214-634-8502.

Task Force donates fraud-fighting equipment to U.S. Secret Service

The Cellular Telecommunications Industry Association (CTIA) Fraud Task Force donated more than $50,000 worth of the latest wireless telecommunications testing equipment to the U.S. Secret Service.

The equipment will be used in the Service's new forensic analysis laboratory that uses the latest technology to analyze cloned phones. Secret Service agents provide expert testimony in court for fraud cases, and the new lab will help to improve the effort.

CTIA's Fraud Task Force estimates that the cellular industry lost $482 million from fraud last year.

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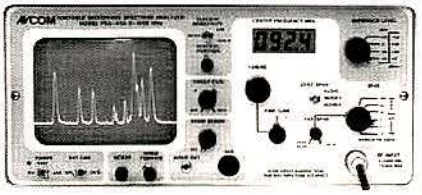
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Readers' choice

Of all the new products and services in the November 1994 issue, the one reprinted here generated the most reader requests for additional information. If you missed it the first time, here is your opportunity to acquire more information on it. Just circle the corresponding Fast Fact Card number on the card found in the back of this issue and mail the card to us.

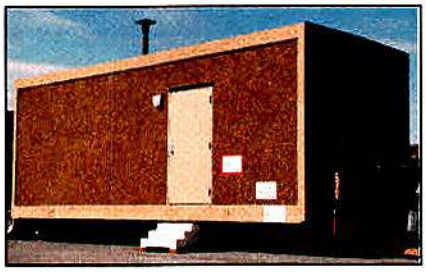
'Shirt pocket' FM transceiver offers power of larger portables



The MicroTalk FM transceiver from **Advanced Videotech** shrinks two-way technology into a 4" × 2" × 1½" "shirt pocket" unit with the power and features of larger portables. The unit has 10 synthesized channels and 1W–5W selected output in the VHF and UHF bands. The channel number LCD is illuminated for use in low-light conditions, and the push-button channel scan operates automatically to help locate specific users. Other features include busy-channel lockout, TX/RX signal strength indicator, battery-saving circuitry, low battery indicator and wide bandwidth frequency capability.

Circle (500) on Fast Fact Card

Exportable communications shelter features light weight, rugged design



The IsoCrete lightweight communication shelter from **Andrew** is 10% lighter than other steel exportable shelters. The shelter has a structural steel perimeter frame and TrussCrete wall panel inserts to form a tough, lightweight, stackable shelter that meets ISO requirements for containers. A typically equipped 12' × 28' IsoCrete shelter weighs about 25,000 pounds, roughly half the weight of comparable glass-fiber or solid concrete shelters, which reduces transportation costs and allows easier access to remote sites. The walls are bullet-resistant to rounds as heavy as .44 caliber. The standard design wind loading is 80mph; floor loading is 125 lbs/ft²; and roof loading is 40 lbs/ft².

Circle (451) on Fast Fact Card

Digitally trunked radio system expands into narrowband version

Ericsson's Private Radio Systems division has released the EDACS-NB, a narrowband version of the EDACS digitally trunked radio communications system. EDACS-NB provides 9,600-baud digital voice, data and signaling on a 12.5kHz channel. EDACS-NB will be available on all EDACS repeaters and a wide variety of portables and mobiles. The narrowband system also provides a migration path to 6.25kHz equivalent spectrum efficency, using Ericsson's Prism technology. Compatible radios can roam across systems operating on either 25kHz or 12.5kHz channels. These systems can be networked to provide a fully integrated communications network on both wideband and narrowband systems. EDACS-NB provides network interoperability with other communications systems including cellular, PCS, telephone and INMARSAT.

Circle (452) on Fast Fact Card

Replacement antenna for Uniden portables comes in two versions



Fixed replacement antennas for the Uniden CP4600/5600/6600 series portable phones are available from **Centurion International**. The fixed replacement is designed both for convenience and to improve performance with fewer dropped calls. The antenna is available in quarter-wave and half-wave versions, types CXC-M5U and CXH-M5U.

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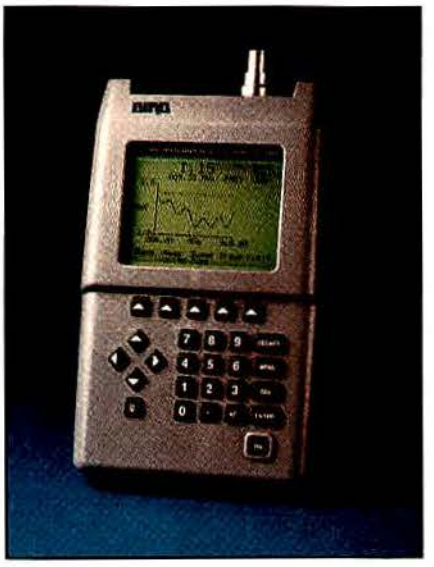


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Circle (76) on Fast Fact Card

Antenna tester speeds installation, troubleshooting at 806MHz–960MHz



The AT-800 antenna tester from **Bird Electronic** measures match condition of communications antenna systems for cellular and other 806MHz–960MHz services. The hand-held tester uses a built-in RF source to measure VSWR, match efficiency and return loss at single frequencies. It also can automatically sweep a user-specified frequency range. Both numeric measurements and high-resolution graphic plots can be displayed. A field strength mode verifies hand-held radios. Features include a pass/fail mode for quick go/no-go testing. A serial interface and optional software can transfer stored measurements to a PC.

Circle (454) on Fast Fact Card

Radio design software adds tiling, topography, antenna pattern options

SoftWright has released version 3.1 of the Terrain Analysis Package (TAP) engineering software. The software allows a company to prepare radio coverage maps in-house and to establish and standardize comparative studies of changes to existing coverage. Coverage maps can now be prepared using a tiling method, specifying a uniform spacing in a region and calculating radio coverage only within a specified geographic region, not necessarily inclusive of the actual transmitter site location. New features include the ability to locate the highest topography near a possible transmitter site and a library of more than 700 popular patterns of Scala, Antenna Specialists, Sinclair, Celwave and Decibel Products antennas.

Circle (455) on Fast Fact Card

Mobile networking software allows host, portable messaging functions

KeyWare from **Racotek** is an open wireless distributed computing environment for mobile communications that uses a client/server server/client architecture. The design allows service agents to perform application and messaging functions on behalf of both host and portable applications. KeyWare is interoperable with industry-standard computer platforms and provides broad wide-area network connectivity. The software is designed to allow rapid integration of mobile data communications with existing and new applications.

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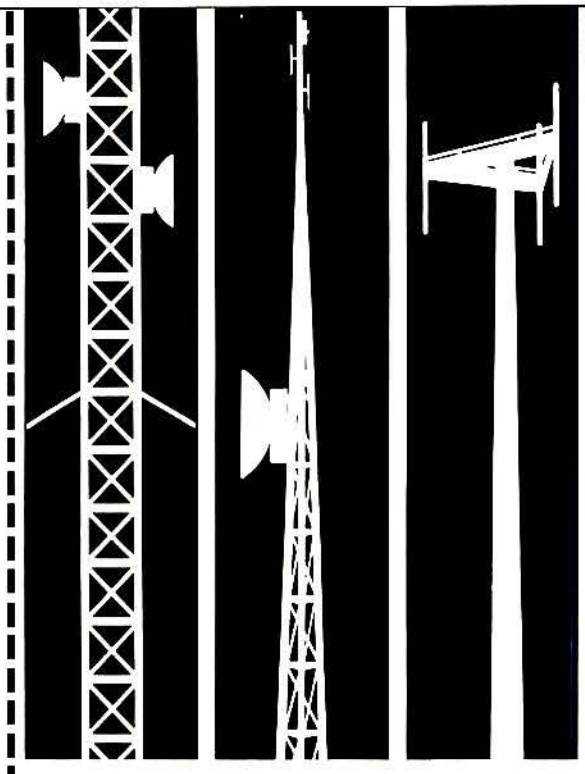
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Circle (77) on Fast Fact Card

Updated coverage software uses propagation model, 3-D antenna patterns

EDX Engineering has released updated versions of its MSITE, SHDMAP and CVR programs. The PC-based RF coverage analysis software is used for two-way land mobile, trunking, SMR, ESMR, cellular (AMPS/TDMA/CDMA/GSM), broadcast and one-way/two-way paging system design. The programs have been revised to include the COST 231 Hata propagation model, as well as a custom model that allows users to set various calculation parameters to match field measurement and drive test data. The user also can specify three-dimensional antenna patterns with mechanical downtilt, create custom boundary-line files on screen and perform talk-back studies.

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Circle (78) on Fast Fact Card

Frequency-synthesized two-way offers selectable power, cloning



The model 70-148 from **Midland International** is a frequency-synthesized, two-way FM portable radio for land mobile service. The 99-channel VHF radio has a frequency range of 146MHz–174MHz and selectable RF outputs of 2W and 5W. Features include an LCD, push-button channel selection and an internal preset squelch. Semi-duplex operation can be programmed for 48 channels. The radio also offers PC programming and cloning and provides scanning by either a programmed scan list or triple watch (two user-selectable priority channels and a home channel). Additional features include monitor function, busy-channel lockout, 83 DCS-- codes and 37 CTCSS tones randomly programmable by channel. The radio has a rotary volume/on-off switch, an MX-type antenna connector, speaker-mic and charge jacks, a battery-saver circuit and a low-battery indicator.

Circle (458) on Fast Fact Card

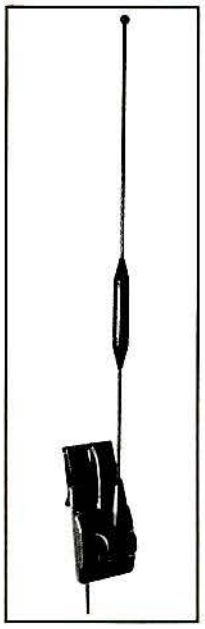
Cylindrical Li battery line expands with three high-energy models



Tadiran Electronic Industries has added three classes of 2/3AA high-energy, high-temperature, cylindrical lithium thionyl chloride batteries to its line. Models TL-2155, TL-5955 and TL-5155 (standard, high-capacity and memory back-up, respectively) have a nominal voltage of 3.6V. Capacities are 1.65Ah at 130mA to 3V. Maximum continuous current is 75mA. All three models have UL component recognition MH12193 and are available with a choice of four terminations. Operating temperatures are −55°C to +85°C with a 135°C upper limit available.

Circle (459) on Fast Fact Card

Clip-mount mobile antenna reduces static and dropped calls



The Window Klip II antenna for portable and transportable phones enables users to avoid vehicle shielding effects that reduce signal strength and hinder performance. The antenna, from **The Antenna Company**, reduces static and dropped calls, improving the performance of in-car equipment by as much as 50%. The antenna features a vinyl-coated metal clip redesigned to provide maximum durability and attach to any window. The Window Klip II features a 3dB-gain, enclosed coil mast and a "car-wash-friendly" locking design.

Circle (460) on Fast Fact Card

Keyboard modification for mobile computing mount improves access



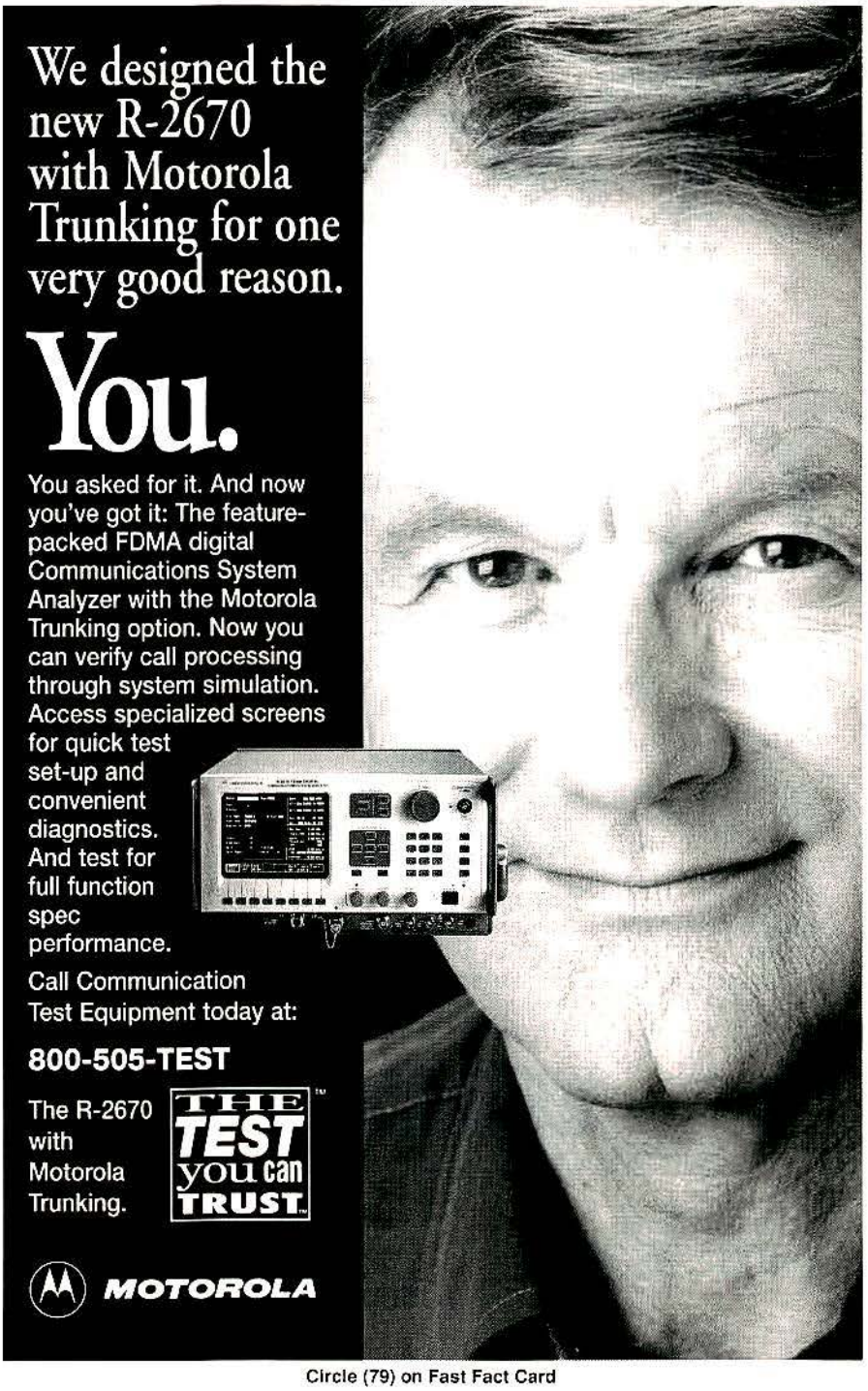
SMC Electro-Mount has created a keyboard platform assembly option for its line of laptop computer mobile installation systems. The model 8KBA-1 assembly, consisting of an 8" adjustable arm support and a universal keyboard adapter plate, attaches to the basic mount support. The adjustable arm allows the keyboard to be tilted and/or turned for more convenient access. The keyboard platform and mount system can be configured for any tablet or pen-based computer.

Circle (461) on Fast Fact Card

Data transmission technology for paging sends photos to mobile units

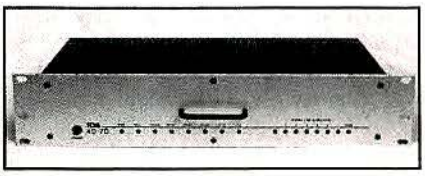
Image APB, developed by **Data Critical**, is a wireless data communications service that interfaces with existing paging networks to transmit data, including photo images, to a mobile receiver equipped with paging capabilities. The service allows law enforcement and security personnel to receive security-camera stills, mug shots or photos of missing children through hand-held computing devices. **PageNet** has already provided its network for the Image APB application and cooperated in demonstrations of the technology. Data Critical's Data-Through-Paging technology is designed to make the sending of data to remote receivers as simple as sending a fax.

Circle (462) on Fast Fact Card



Circle (79) on Fast Fact Card

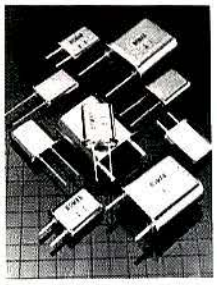
Community repeater tone panel, interconnect, supports 160 users



IDA has added the model 40-70 to its line of interconnects. The full-featured community repeater tone panel and interconnect's standard features include: 160 users; full CTCSS and CDCSS capability; wild ANI; dispatch networking; cross-busy circuitry; and plug-in telco cards. Options are available for voice security scrambling, voice prompts, multiple phone lines and airtime billing buffer and software.

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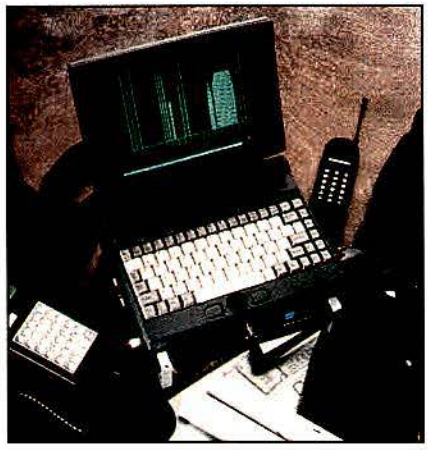
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Circle (80) on Fast Fact Card

Wireless measuring instrument verifies RSSI for all TX standards



The SpectrumTracker from the **Grayson Electronics** division of Allen Telecom Group is dedicated solely to providing carriers with accurate RSSI readings. The instrument may be used for AMPS, narrowband AMPS, TDMA, ESMR, paging and PCS frequencies. The unit scans carrier-defined frequencies and displays signal strength and interference graphs on a carrier's PC. The 10-pound unit is portable to allow access to locations that limit the use of larger equipment. SpectrumTracker holds as many as four measurement receivers and can run simultaneous system checks on the same number of wireless system standards.

Circle (464) on Fast Fact Card

Compact direction-finding receiver allows remote control, monitoring



O A R has released the model 4400 direction-finding (DF) processor/receiver for mobile or fixed-station applications. Depending on the antenna configuration selected, the model 4400 can provide accurate DF capability from 0.5MHz to 1,300MHz. The compact, portable unit has a backlit LCD and features an embedded CPU with bit-mapped graphics display, a standard PC parallel printer port, a compatible keyboard interface and a VGA monitor port. Remote control and monitoring functions enable unattended operation.

Circle (465) on Fast Fact Card

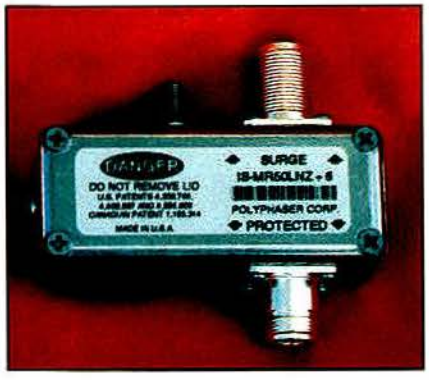
Commercial data controller offers trunked operation, encryption



Advanced Electronic Applications has released a professional commercial version of its amateur radio data controller. The PK-90 is a 1,200bps (2,400bps optional) packet-only data controller. Features include SMR/trunked radio operation, security encryption, commands for remote operation, extended temperature ranges and full/half duplex modes. The controller works in conjunction with a computer and an ordinary 16F3 25kHz-spaced FM or SSB radio on any voice path including FM, SS microwave, cellular, or a combination. Users can share the channel with voice and other data users simultaneously. As many as 10 connections can be made simultaneously.

Circle (466) on Fast Fact Card

Lightning protector guards GPS receivers with active antennas



PolyPhaser has introduced a specially designed coaxial protector for GPS receivers with active antennas. The IS-MR50LNZ+6 protects in-line amplifiers and GPS receivers while providing optimal protection for both dc and RF paths on coax. The protector was tested on GPS receivers for ultra-low surge throughput with measured throughput energy of 0.4 microjoules at 2kV (3/250ns waveform). Providing both positive and reverse voltage protection, the unit exhibits low loss as well as low VSWR over a large bandwidth. The protector has simple coax and bulkhead-mountable ground connections.

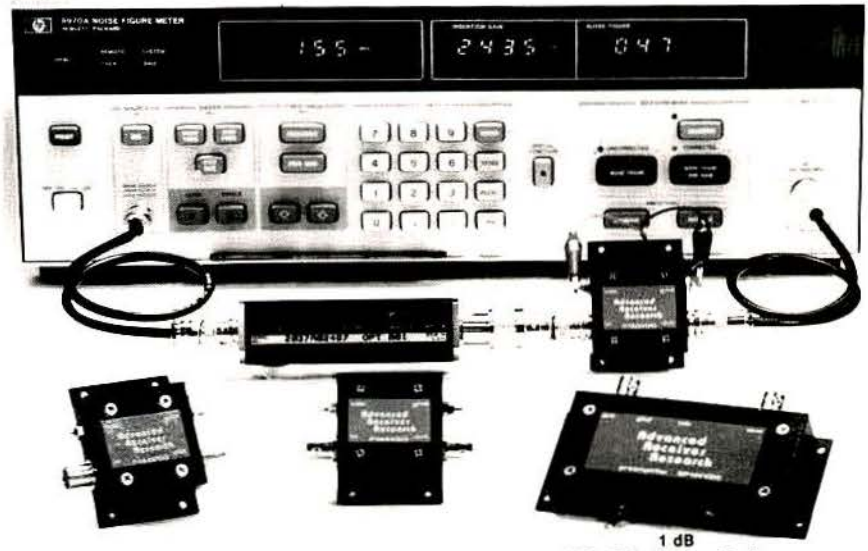
Circle (467) on Fast Fact Card

Software adds dispatch capabilites to personal communicator's tools

DispatchIt is a work order field service application developed by **BellSouth Cellular** (BSCC) and PDA Dimensions for use with BSCC's Simon personal communicator. DispatchIt software runs on Simon and enables companies with field service operations to use the communicator's two-way wireless voice and data capabilities for business management. The software allows work orders to be keyed into a Windows-running PC, which wirelessly transmits those messages to the communicator over the cellular network. The host/server software runs on a Windows 486 PC and a landline Hayes-compatible modem. The client/remote software resides on a PCMCIA card for Simon.

Circle (468) on Fast Fact Card

High Performance vhf/uhf preamps



Receive only	Freq. Ranges (MHz)	N.F. (dB)	Gain (dB)	1 dB Comp. (dBm)	Device Type	Price
P30VD, P35VD, P40VD, P45VD	30-35, 35-40, 40-45, 45-50	<1.3	15	0	DGFET	$ 44.95
P30VDG, P35VDG, P40VDG, P45VDG	30-35, 35-40, 40-45, 45-50	<0.5	26	+12	GaAsFET	$109.95
P150VD, P160VD, P170VD	150-160, 160-170, 170-180	<1.5	15	0	DGFET	$ 44.95
P150VDA, P160VDA, P170VDA	150-160, 160-170, 170-180	<1.1	15	0	DGFET	$ 56.95
P150VDG, P160VDG, P170VDG	150-160, 160-170, 170-180	<0.5	24	+12	GaAsFET	$109.95
P450VD, P460VD	450-460, 460-470	<1.8	15	−20	Bipolar	$ 49.95
P450VDA, P460VDA	450-460, 460-470	<1.2	16	−20	Bipolar	$ 74.95
P450VDG, P460VDG	450-460, 460-470	<0.5	16	+12	GaAsFET	$109.95
P800VDG, P830VDG, P860VDG	800-830, 830-860, 860-890	<0.6	19	+12	GaAsFET	$119.95
Inline (rf switched)						
SP30VD, SP35VD, SP40VD, SP45VD	30-35, 35-40, 40-45, 45-50	<1.4	15	0	DGFET	$ 74.95
SP30VDG, SP35VDG, SP40VDG, SP45VDG	30-35, 35-40, 40-45, 45-50	<0.55	26	+12	GaAsFET	$139.95
SP150VD, SP160VD, SP170VD	150-160, 160-170, 170-180	<1.6	15	0	DGFET	$ 74.95
SP150VDA, SP160VDA, SP170VDA	150-160, 160-170, 170-180	<1.2	15	0	DGFET	$ 86.95
SP150VDG, SP160VDG, SP170VDG	150-160, 160-170, 170-180	<0.55	24	+12	GaAsFET	$139.95
SP450VD, SP460VD	450-460, 460-470	<1.9	15	−20	Bipolar	$ 79.95
SP450VDA, SP460VDA	450-460, 460-470	<1.3	16	−20	Bipolar	$104.95
SP450VDG, SP460VDG	450-460, 460-470	<0.55	16	+12	GaAsFET	$139.95

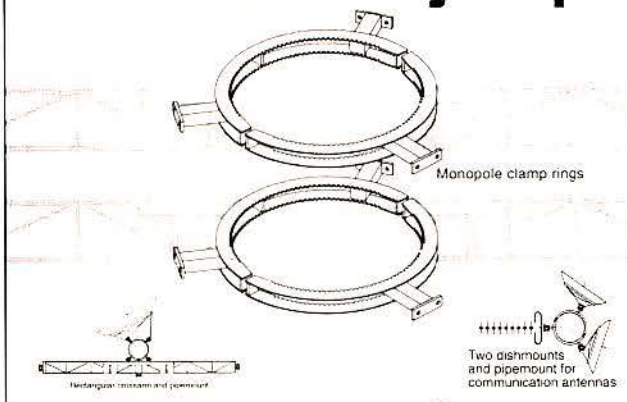
Every preamplifier is precision aligned on ARR's Hewlett Packard HP8970A/HP346A state-of-the-art noise figure meter. RX only preamplifiers are for receive applications only. Inline preamplifiers are rf switched (for use with transceivers) and handle 25 watts transmitter power. Mount inline preamplifiers between transceiver and power amplifier for high power applications. System S/N improvement 6-14 dB typical. Other amateur, commercial and special preamplifiers available in the 1-1000 MHz range. Please include $2 shipping in U.S. and Canada. C.O.D. orders add $2. Air mail to foreign countries add 10%. Order your ARR RX only or inline preamplifier today and start hearing like never before!

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Circle (81) on Fast Fact Card

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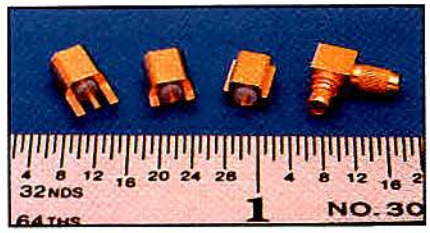
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Circle (82) on Fast Fact Card

New products

Connectors provide high-density RF interconnections



The MicroMate connectors from **Amphenol** are designed for high-density, lightweight RF interconnections for wireless communications and data, including PCMCIA. The 50Ω connectors have a frequency range of dc to 6GHz with a temperature range of −65°C to +165°C. The brass-and-gold-plated connectors feature positive snap mating and accommodate RG-178 and RG-316 cables.

Circle (469) on Fast Fact Card

Software unites network server with paging network

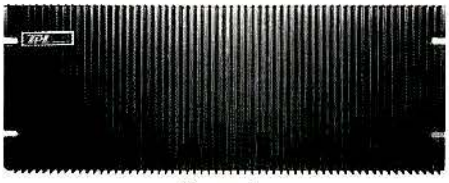
Air Apparent for NetWare, from **Motorola's** Personal Communicator Systems and Software division, is a wireless communications software application. The application integrates paging technology with Novell NetWare and NetWare Directory Services. By uniting the network server with a paging network, Air Apparent allows business users to send wireless messages to remote personnel from any client on the local area network. Users can seamlessly send a message to a file server residing on the network by using their existing E-mail application.

Circle (470) on Fast Fact Card

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We've gone from **GOOD** to **BETTER** with our new RXR Series Base Station/Repeater Package

RX Series Base Station/Repeater Amplifier Package*

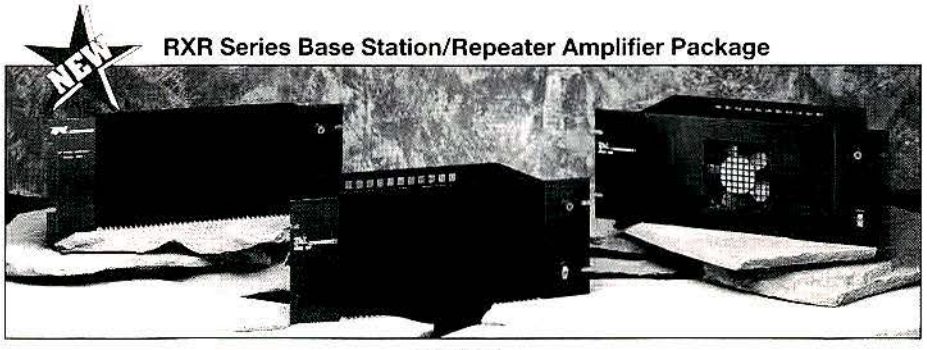


Good

TPL introduces the latest innovation in reliable, cost effective, continuous duty power amplifiers. This Series incorporates all the features of the very popular RX Series but in a lighter, more modern package. This package will accept any TPL amplifier up to 120 watts, low band through 960 MHz. It can be provided with or without a cooling fan. Both configurations are designed with a flush front, allowing for installation into a cabinet, leaving sufficient room for air flow with the door closed.

*Replaced by RXR Series

RXR Series Base Station/Repeater Amplifier Package



Better

The amplifier has the fuse and off/on switch conveniently located on the front panel. It can be supplied with or without a DC power supply.

The RXR Series is the most versatile unit of its type on the market today, and it comes from the leader in power amplifiers for over 23 years. TPL is so confident with the new RXR Series that they'll cover it with a **new 2 year warranty.**

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Circle (83) on Fast Fact Card

Vehicle intercom employs recorder, eliminates voice clipping, noise



Firecom's 3010 Intercom series for emergency vehicle communications employs a "hush" circuitry to significantly lower ambient noise levels for the user. With the removal of the squelch control, transmission voice clipping is completely eliminated. Every inbound transmission is automatically recorded by a digital voice recorder. The voice-activated intercom has a digitally controlled touch pad operating panel for setting volume, dispatch playback or choosing a primary transmit radio. Headset improvements include a military-style single plug, an adjustable flex boom with positive detent positioning and an under-helmet design.

Circle (471) on Fast Fact Card

Tower light monitor/reporter calls responsible party during outage

The tower light monitor/reporter from **Bramco** dials three preprogrammed phone numbers in the event of a tower light burnout and delivers a recorded voice message. The monitor has four different inputs and a different message for each input. Phone numbers and voice messages remain in memory for as long as six weeks without power, although battery backup is available as an option. Inputs are delay-adjustable to prevent nuisance-tripping. The system operates on 12Vdc from an outlet power supply. Options include backup dry and rechargeable batteries, an acknowledge decoder and a control decoder.

Circle (472) on Fast Fact Card

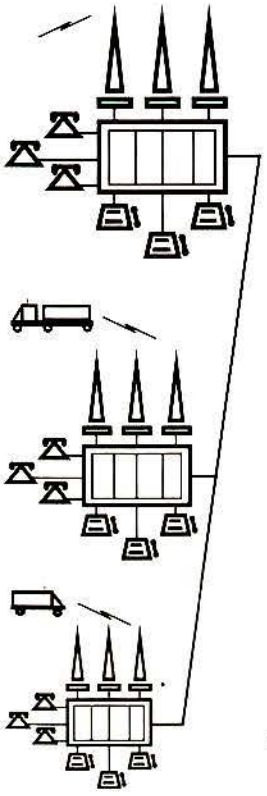
CAD/AVL package enhancements provide more industry specificity



Advanced Control Technology has added industry-specific user interfaces to its CadPak computer-aided fleet dispatching and vehicle-tracking system. Electronic work order forms enhance pen-based user interfaces for applications in the gas and oil, cable, telephone and utilities industries. The graphics-based CAD/AVL system features data-based records management capabilities, "point and click" dispatching of service work orders to selected vehicles and two-way digital messaging.

Circle (473) on Fast Fact Card

Wide Area Voice/Data Networks



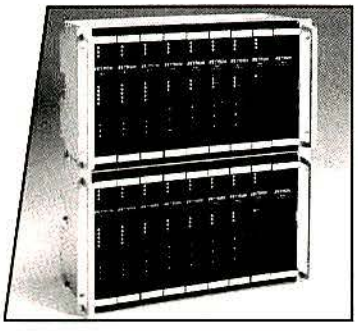
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Circle (84) on Fast Fact Card

GPS-based tracking software provides solution for fleet management

The PCV*trak* automatic vehicle location system, manufactured by Trimble Navigation and distributed by **Dataradio**, is a fully integrated, real-time GPS-based tracking software solution. The product includes data archiving, situation display and total management of system components. The system is also a "plug-and-play" application when used with Dataradio's Vehicular Information System (VIS) products. PCV*trak* operates on a 486/33 PC that becomes the hub of the system. The software provides graphic display, communications control and tracking management for fleets of as many as 35 vehicles.

Circle (474) on Fast Fact Card

Frequency extension option brings test set range up to 2.0GHz mark



Wavetek has doubled the frequency range of its Stabilock 4032 communication test set with a fast-mounting, plug-in hardware option. The option extends the test set's frequency range to 2.0GHz, allowing the testing of DCS 1800 and DCS 1900 radiophones or measurements on cordless phones to DECT standard. The new option extends permissible bandwidth for modulating and demodulating signals and upgrades the frequency range of the unit's spectrum analyzer to 2.3GHz. The retrofit also can be used on older models such as the model 4031 test set.

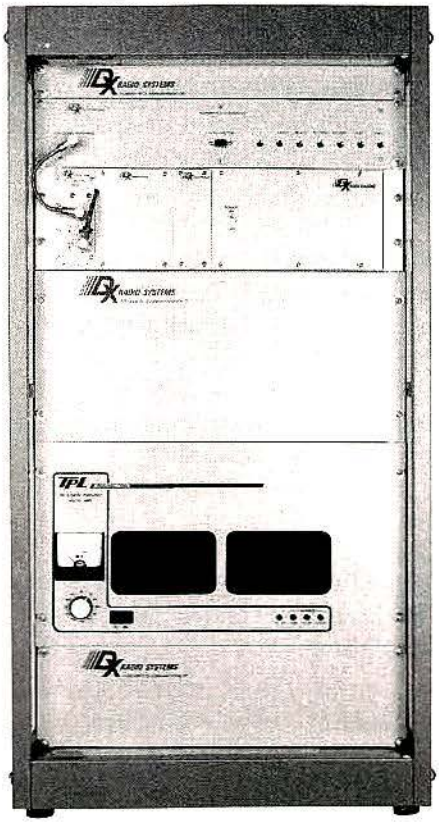
Circle (475) on Fast Fact Card

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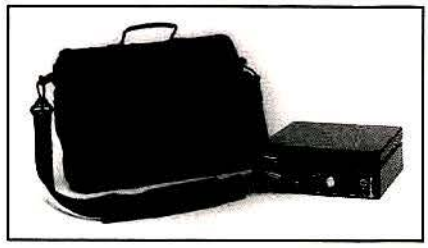
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Circle (85) on Fast Fact Card

Portable unit provides in-building tracking, location of cellular phones



The Covert Locator is a small, transportable cellular direction-finding system from **Communications Test Instruments**. It provides cellular phone tracking and location within buildings or in enclosed areas. Specifically designed for the cellular system operator or law enforcement agencies, the unit is carried over the shoulder in an inconspicuous soft case. A small wireless earpiece allows monitoring of selected cellular phone calls. An audio tone indicates signal strength and direction to the target cellular phone. The unit automatically tracks specific phones by cellular phone number (MIN) and follows subsequent cellsite handoffs. The control information is fed to the Covert Locator over an RF link from a master Locator system in an external tracking vehicle.

Circle (476) on Fast Fact Card

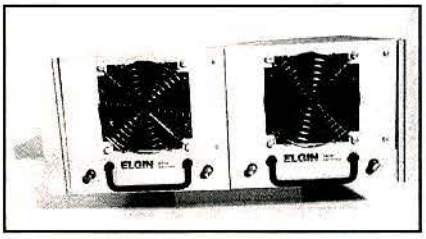
Battery system supports multiple chemistries



The CASP (Charger, Analyzer, Sequencer and Power supply) communications battery support system from **Christie Electric** has six battery connection channels and recognizes the individual models that are being processed. All operations are controlled from the front keyboard. The charger reduces battery impedance and internal pressure and lowers charge temperature. NiCd batteries are reconditioned in a series of three charge and discharge cycles. Batteries with NiMH, lead-acid or AgZn chemistries also can be charged. The model CASP/2000 may be programmed from its own keyboard, can graph charge/discharge cycles on a serial printer, and can serve as a 350W programmable power supply. The model CASP/1200 is a cost-effective model preprogrammed for as many as 32 popular communications battery types.

Circle (477) on Fast Fact Card

Three rectifier output versions offer alarms, remote



Elgin Telecommunication Power Systems' Switchmode Rectifier is a 2,700W lightweight, compact module available in three output versions: 48V at 50A, 24V at 100A and 12V at 100A. Standard features include a modular hot plug-in design, a power factor correction of 99% and a brushless dc fan for forced-air cooling. There are alarm indications for input/output, current limit and overvoltage shutdown. Remote power control is also provided. Metering, alarm, Form C output contacts and float equalize functions are available with a separate control module.

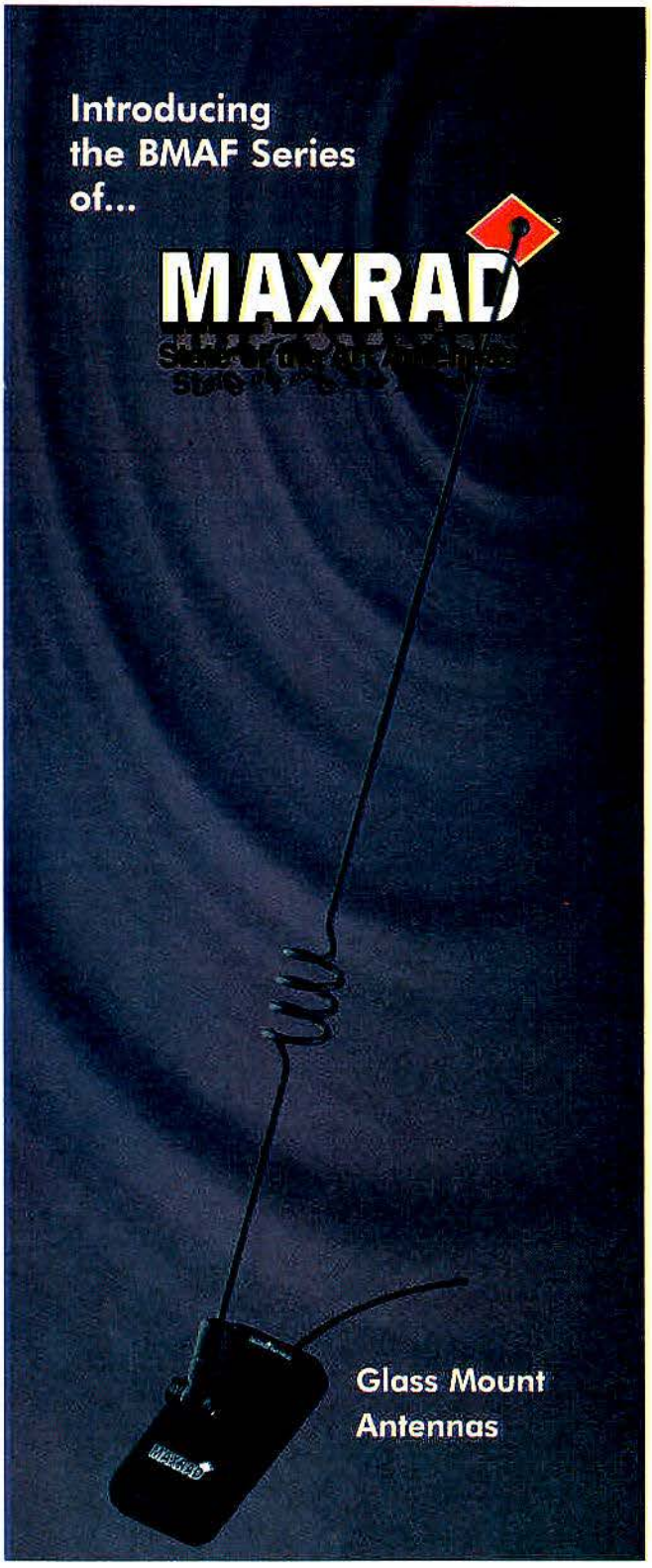
Circle (478) on Fast Fact Card

Foam-dielectric cable keeps low loss over long runs



Andrew's LDF12-50 is a 2¼", 50Ω coaxial cable for use in wireless applications including SMR, paging and cellular. The large-diameter, foam-dielectric coaxial cable is designed to offer comparable performance to equivalent-size, low-loss, air-dielectric cables. Suited for long runs where low loss is critical, the cable has a foam polyethylene (PE) dielectric with a solid copper outer conductor. At 1,000MHz, the attenuation is 0.682dB/100 feet, and the average power rating is 5.52kW. A Type N female connector is available for use with the cable.

Circle (479) on Fast Fact Card



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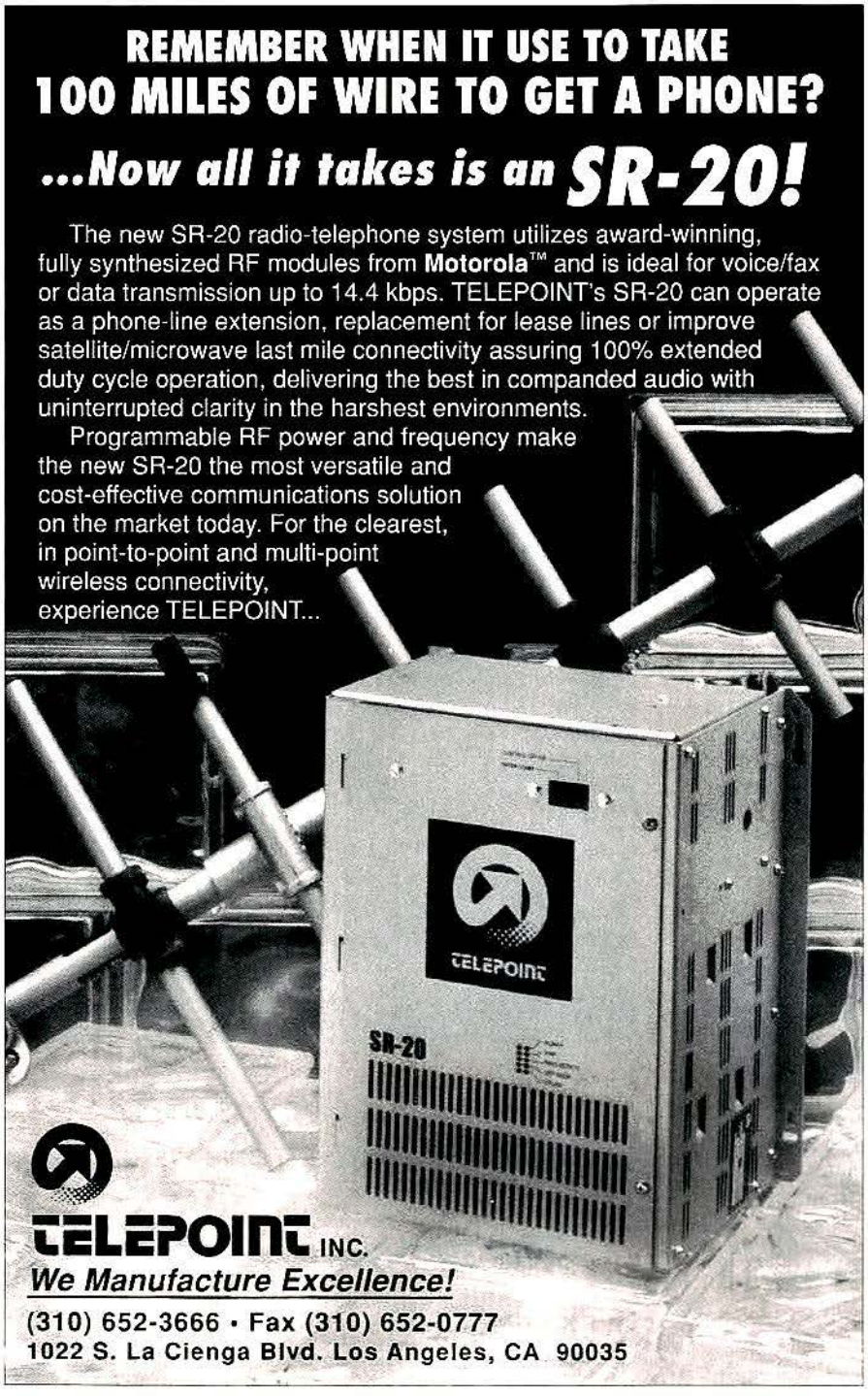
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Circle (86) on Fast Fact Card

Public safety communications service offers custom systems, hardware

Advanced Digital Systems has entered the public safety communications market with a line of radios, data radio modems, automatic vehicle location systems, vehicle status communicators, alphanumeric data terminals, in-vehicle PCs, printers and data communications software. The company also provides system integration and hardware/software customization services. Systems are composed of "scalable" products—public safety agencies can mix and match system components such as data radio modems, radios and data terminals or PCs to fit immediate performance and budget requirements with the knowledge that they can upgrade those components for future needs.

Circle (480) on Fast Fact Card



Circle (87) on Fast Fact Card

Trunked programmable mobile handles voice, data, GPS functions



KAVIcomm's KV VHF/UHF mobile radio is programmable, without interface, as a conventional or MPT 1327 trunked radio. It has a built-in modem, software and RS-232 port for data transmission, GPS, printer or PC connection. The radio can be programmed to more than 400 channels (at 12.5kHz channel separation), 700 IDs and 100 groups per fleet. It has 25 preprogrammed, plus 10 user-programmable, memories. When connected to a PC, the radio establishes a small self-sustained mobile or stationary dispatch, capable of logging incoming and outgoing speech, data and messaging calls.

Circle (481) on Fast Fact Card

Low loss cable kit for land mobile provides 6dB noise advantage



Richard Hirschmann of America has issued a low-loss cable kit to complement its ¾" MCA-2000-NMO shielded antenna mount. The new ¼" cable kit, number 927908-780, uses Times Microwave LMR-240 cable and features a solid copper center conductor, a foam dielectric, an unbonded foil shield, a 90% braided shield and a PVC jacket. The characteristic loss is 7.6dB per 100 feet at 900MHz. The cable is supplied in 17" lengths and is equipped with a female FME connector for use with the mobile antenna mounts. The use of cable with mount is designed to provide a noise advantage of 6dB when compared to standard open junction mounts and standard RG-58/U cable.

Circle (482) on Fast Fact Card

Selection guide covers solar electric equipment

The third edition of **Hutton Communications'** product selection guide contains more products and more pictures of LMR/SMR, paging, solar electric and celluar equipment than the previous issue. The guide features items from more than 80 manufacturers. The products are organized into 20 categories.

Circle (350) on Fast Fact Card

Brochure introduces line of PCM/Optical measuring instruments

A 12-page brochure titled "The New Wave in Communications" provides an introduction to **Antritsu Wiltron's** line of PCM/Optical measuring instruments. The color brochure outlines specifications for instruments designed to test digital and optical communications networks.

Circle (351) on Fast Fact Card

Catalog features crystals, hybrid oscillators

Five new items are among the crystals and hybrid oscillators listed in the latest through-hole products catalog from **M-tron Industries.** The 32-page catalog, devoted to through-hole products for a wide variety of applications, contains complete descriptions and specifications for products including microprocessor crystals, AT strip crystals, microprocessor clock oscillators and surface-mount clock oscillators.

Circle (352) on Fast Fact Card

Catalog contains signaling products

The1995 signaling products catalog and updated price list is available from **Vega.** The products described in the catalog are designed to meet signaling requirements—whether for tone-remote or dc remote-control consoles, remote station adapters, tone encoders and decoders or any of a wide variety of system modules (line termination cards, summing amplifiers, line drivers, single-tone encoders and decoders, notch filters and relay cards.)

Circle (353) on Fast Fact Card

Catalog includes headsets

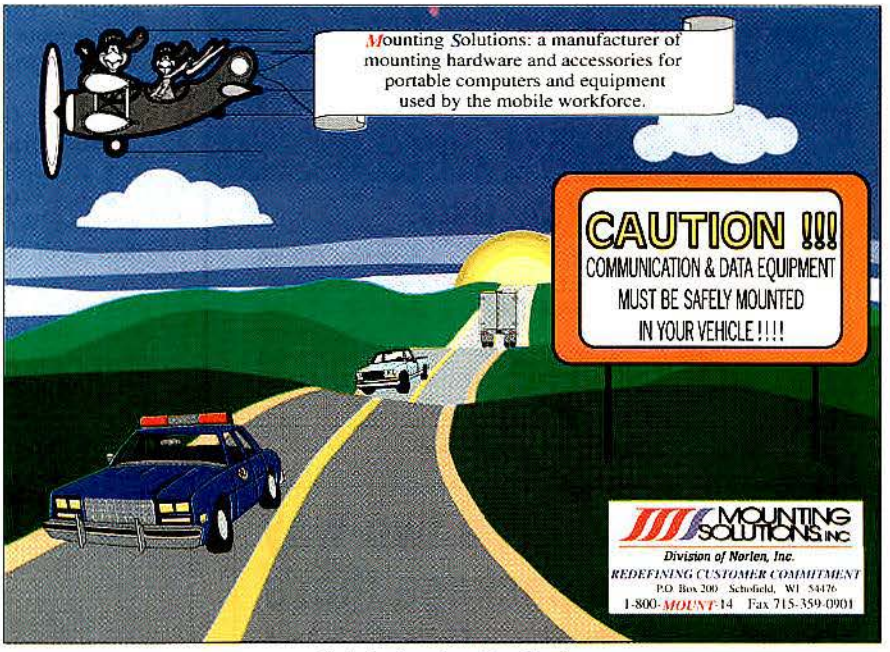
A 72-page color catalog from **Hello Direct** contains 10 pages of headsets and accessories, including cordless, Ultralight, dual and solo; pagers; cellular products, including mounts, replacement antennas, cases, batteries, battery eliminators, battery conditioners/chargers; and many other communications products.

Circle (354) on Fast Fact Card

Catalog describes local area network products

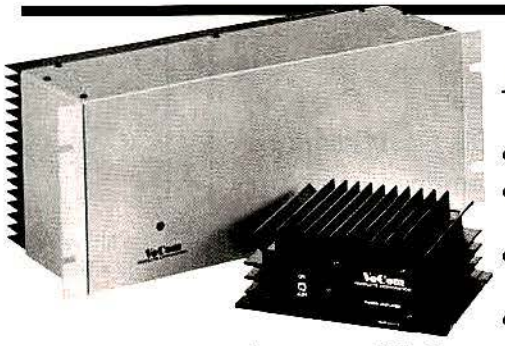
A new LAN catalog from **Jensen Tools** contains selection charts, diagrams, technical data and illustrations throughout its 51 pages. The catalog includes a simple illustration of common LAN topologies and the answers to the most commonly asked LAN questions. The catalog lists LAN starter kits, which include everything necessary to network two PCs together, with optional add-on kits for additional PCs. Other products featured include cable; LAN software; data switchers; cards; adapters; hubs; converters; transceivers; patch panels and other wire distribution products; specialty tools and tool kits; and technical manuals.

Circle (355) on Fast Fact Card



Circle (88) on Fast Fact Card

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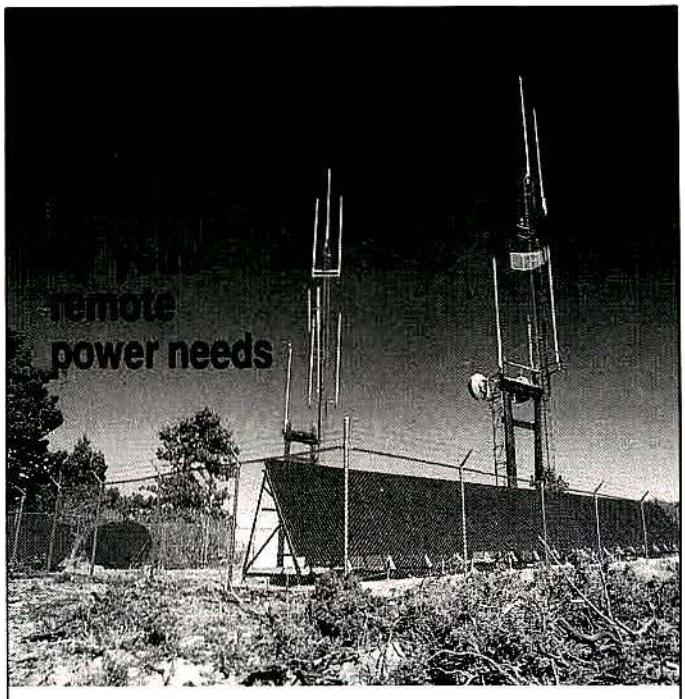


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Circle (90) on Fast Fact Card

People

Changes at Transcrypt International, Lincoln, NE:

Jesus Abreu leaves Sony Electronics, Atlanta, GA, to become director of international sales, Latin America at Transcrypt.

Mike Huntriss departs British Encryption as managing director to join Transcrypt Europe, London, England, as managing director.

Iain Ivory extis GEC-Marconi Secure Systems, England, as senior engineer to join Transcrypt Europe as senior engineer.

David Dilley leaves Motorola, Scottsdale, AZ, as senior software engineer, to become senior development engineer at Transcrypt in Lincoln.

Devra Fuller leaves Del Norte Technology, Euless, TX, as manager of marketing and sales support to become marketing administrator for the Decibel Products division, Dallas, of Allen Telecom Group, Cleveland.

Changes at Geotek Communications, Montvale, NJ:

Randi Friedman, in-house counsel for Geotek, advances to vice president of corporate culture and development.

Bob Klass, departs McCaw Cellular Communications, Kirkland, WA, as a marketing professional, to join Geotek as director of marketing/wireless data applications.

William E. Gibson, retires as president of Digital Microwave, San Jose, CA. He will continue to be involved with the company in a consulting role and will remain a member of the board of directors.

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Don G. Fontana exits PCBX, Santa Ana, CA, as vice president of marketing to join LeBlanc Communications as marketing manager of the telecommunications division in Sacramento, CA.

Changes at Dataradio, Atlanta:

Steve Beeferman, vice president, marketing, advances to vice president, strategic planning and corporate development.

Catharine Vinson, manager, corporate communications, advances to vice president, marketing, USA.

C.J. Stambaugh, sales support for fixed and mobile products, moves up to customer service specialist, COR products.

Cheryl Lynne Fulton, sales support for fixed and mobile products, advances to customer service specialist, COR products.

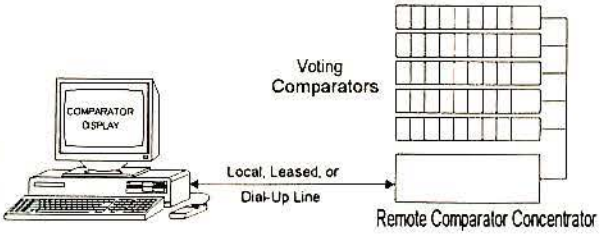
David Hammick departs E.F. Johnson, Burnsville, MN, as national sales manager, telemetry products, to join Dataradio as account manager, COR products.

Gary Correia leaves Coded Communications, Carlsbad, CA, as district sales manager to become area manager, public safety sales for Dataradio.

Dave Williams exits Harris/Electronic Systems Division, Melbourne, FL, as systems engineer and technical team leader to join SmartLink, Wallingford, CT, as manager of systems engineering.

Harry L. Latham III leaves SkyTel as vice president of marketing to join PCS Development, Greenville, SC, as senior vice president, sales and marketing.

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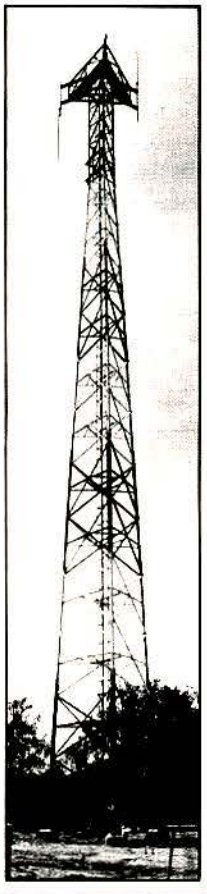
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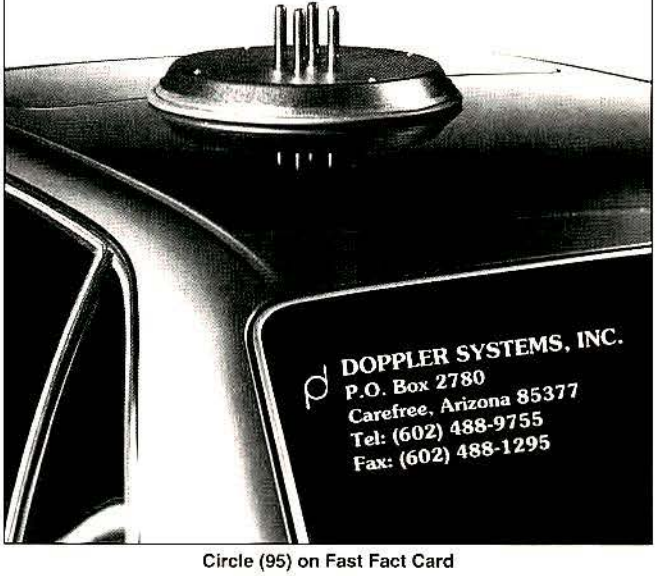
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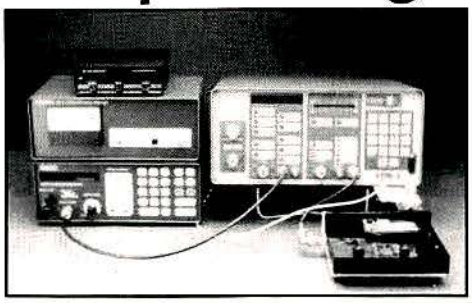
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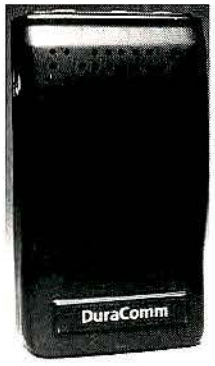
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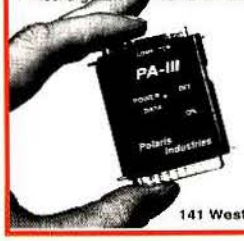


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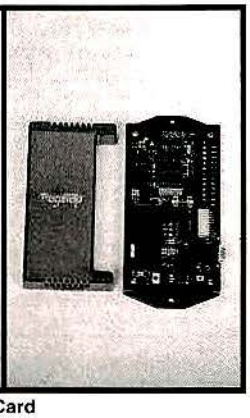
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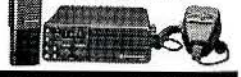
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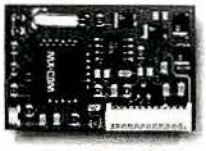
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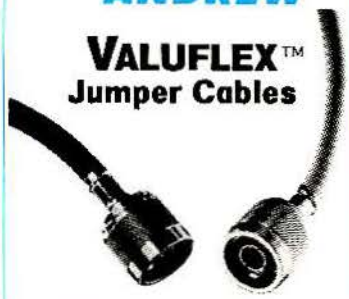
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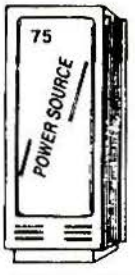
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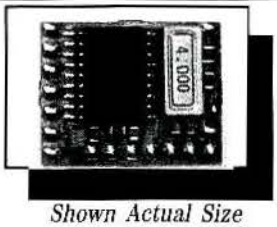
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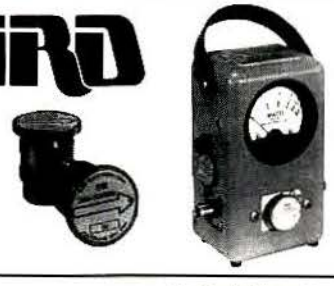
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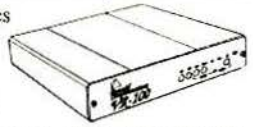
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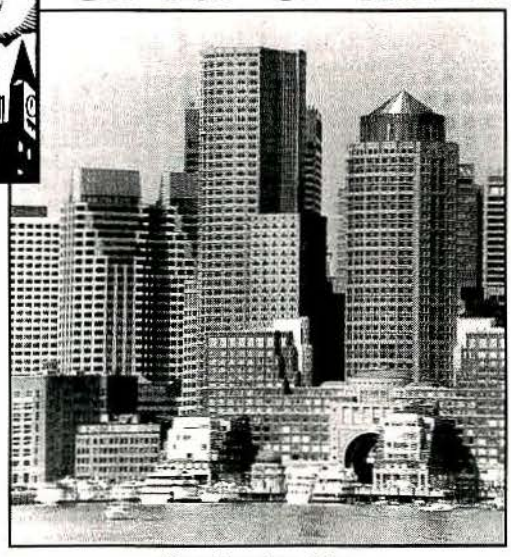

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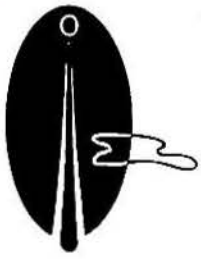
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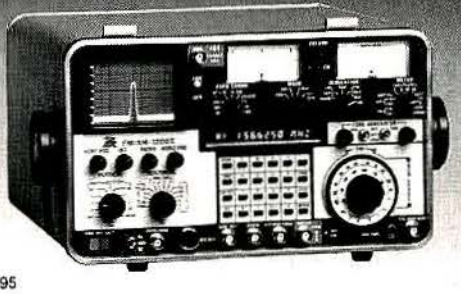
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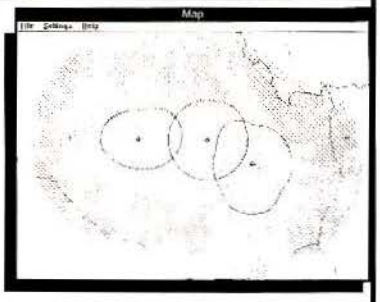
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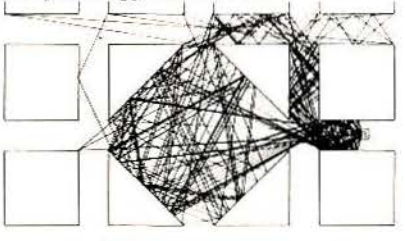
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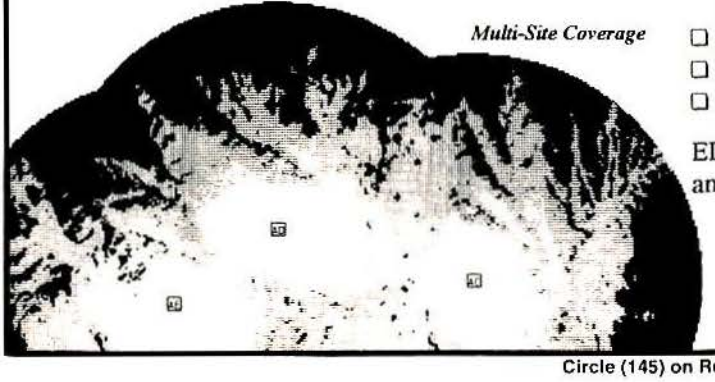
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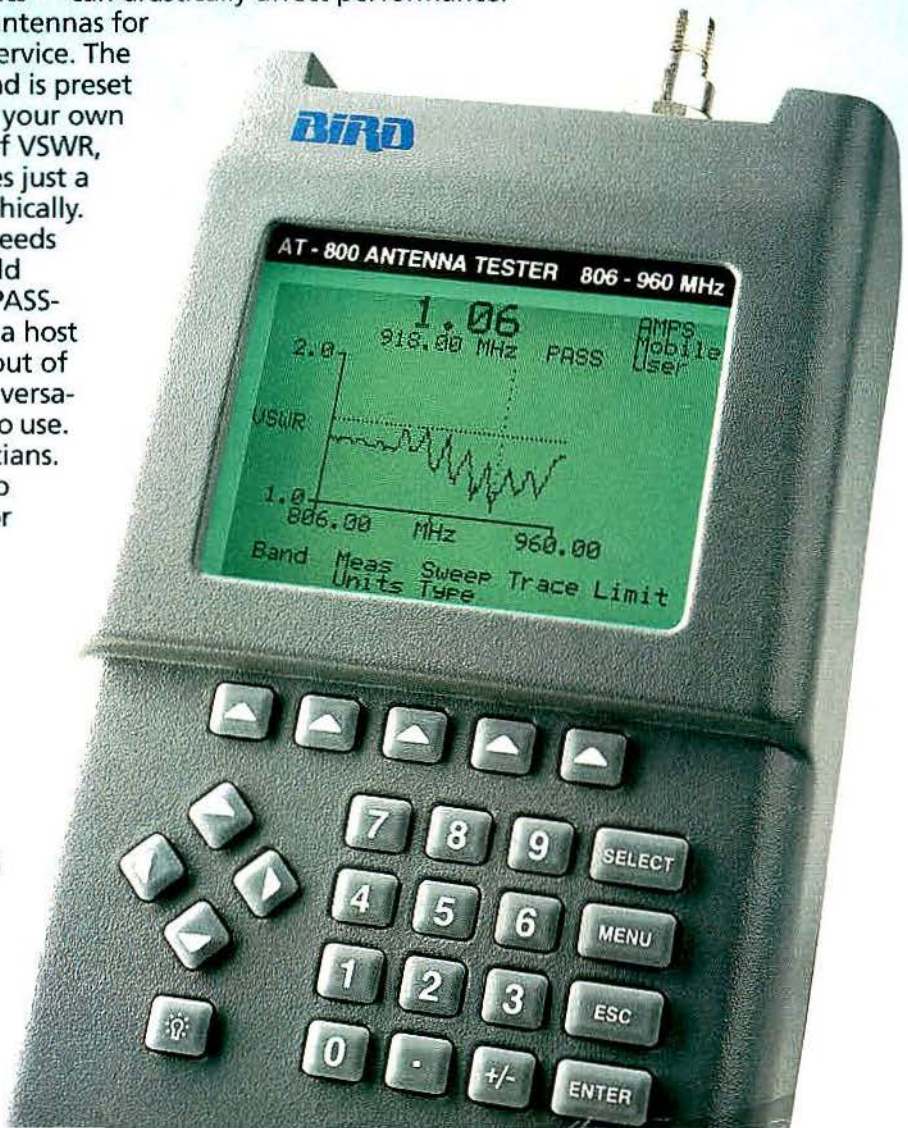
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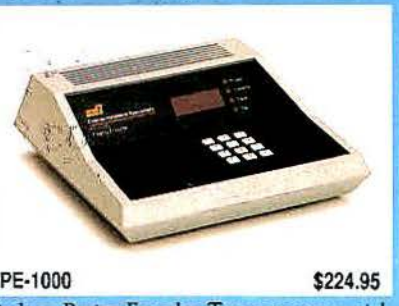
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